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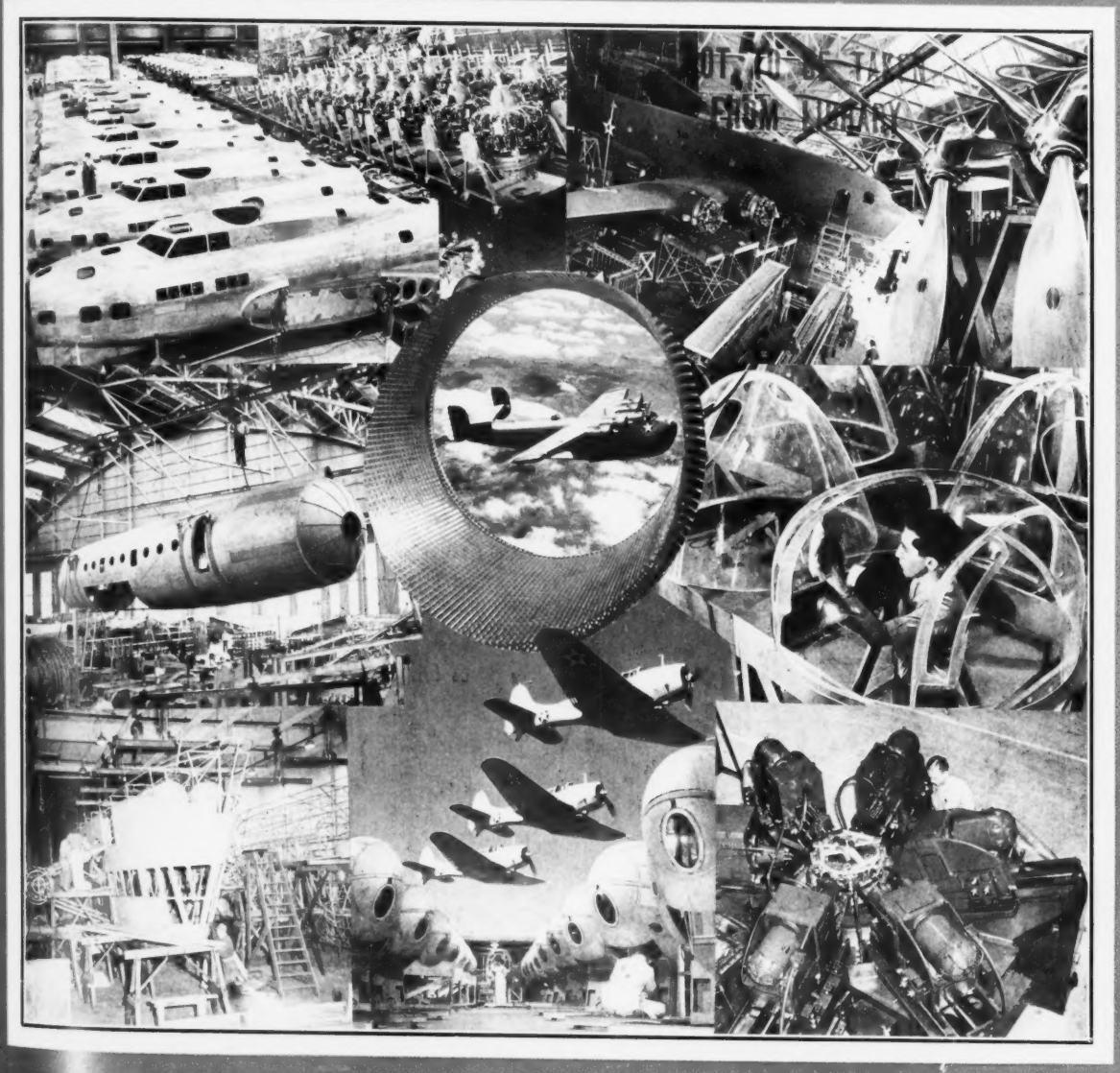
NOVEMBER 1942



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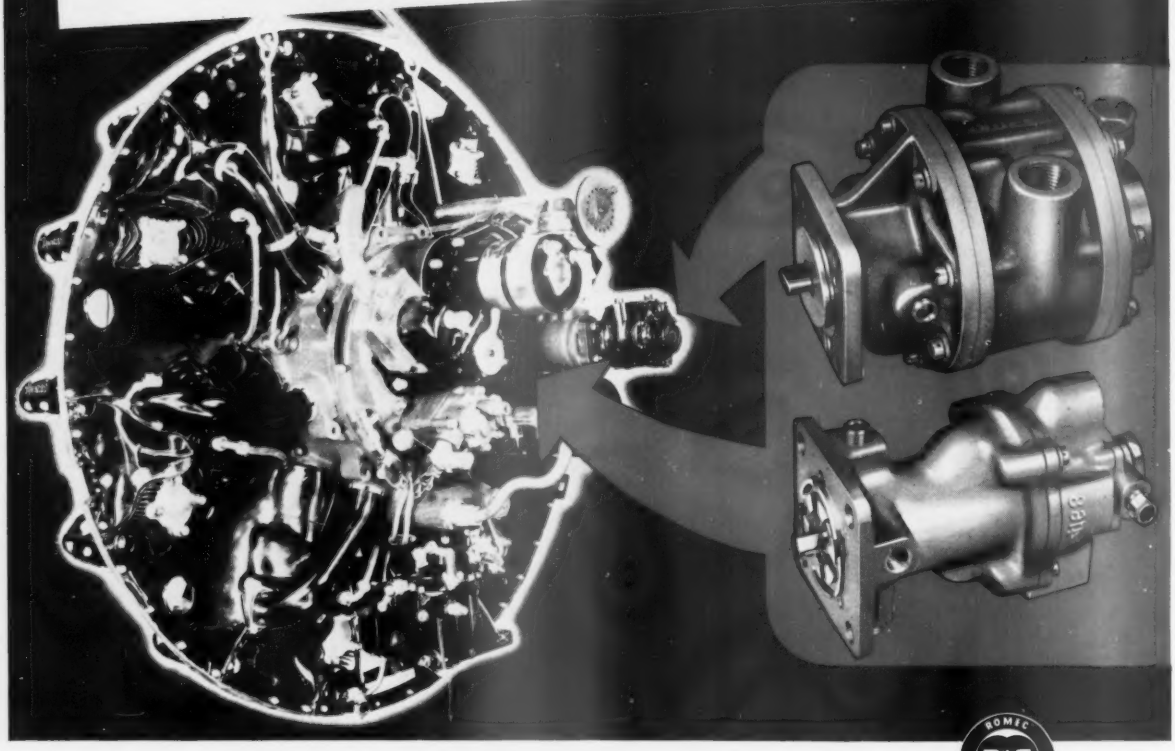

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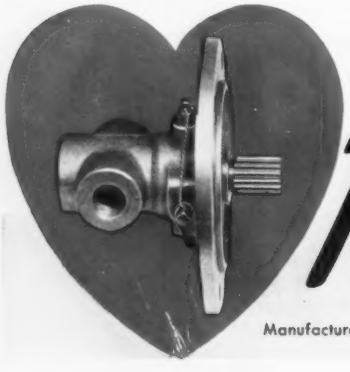

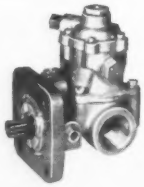

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AERONAUTICAL ENGINEERING REVIEW

Published Monthly by the Institute of the Aeronautical Sciences Inc.

NOVEMBER, 1942

VOLUME 1 NUMBER 8

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CONTENTS

Cover Illustration: A composite of covers from previous issues of the Review.

Institute of the Aeronautical Sciences—The First Ten Years, 1932–1942 7

Articles

Aeronautical Research . . . Jerome Clarke Hunsaker 21

The Automatic Radio Compass . . . . . Wilbur L. Webb and Gerald O. Essex 23

Index to Company Contributions to the Progress of Aeronautics, 1932–1942 5

Reviews

Periodicals 161

Government Publications 195

Books 197

- The History of the United States Army
- Strategic Material in Hemisphere Defense
- Attack: A Study of Blitzkrieg Tactics
- America Fledges Wings
- They Were Expendable
- Private Pilot's Handbook
- Navy Wings
- Air Patrol
- Aircraft Sheet Metal Construction and Repairs
- Blueprint Reading at Work
- Shop Mathematics at Work
- The Physics of Aviation: An Elementary Text on the Theory of Flight
- Junior Aviation Science
- Map Reading and Avigation
- Our New Army
- Scale Model Aircraft That Fly
- Junior Air Raid Wardens
- Blueprint for Victory
- Astrographics
- The Birth of Flight
- Frontier by Air
- Nuevo Diccionario Tecnico—Commercial
- Theory of Flight and Aircraft Engines
- Practical Mathematics of Aviation
- Aeronautics Aircraft Spotters' Guide
- Convoy
- The Book About Aircraft
- Who's Who in Aviation

House Organs and Catalogues 207

Appreciation to Corporate Members 212

From the Industry 213

Institute News 220

Membership Roster 228

Directory of Aircraft Products and Services 256

Index to Advertisers 259

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A Tribute to the Nation's
AERONAUTICAL ENGINEERS

The nation's aeronautical engineers, designers and technicians began preparing for war long before others of us believed war possible.

They spent long hours at drafting boards, in laboratories and in hangars. They subjected parts and procedures to revision and adjustment, always improving. With a sense for the future they painstakingly built the preliminary models of planes that now give more than they take in any sky.

And they helped develop the air transport industry, an industry kept so precisely conditioned in peacetime that it changed to war footing virtually overnight; an industry so well equipped for long-range, precision flying that it was able to establish a world-wide air-supply service in a matter of months.

This war year, marking the Tenth Anniversary of the Institute of the Aeronautical Sciences, gives fitting opportunity to pay tribute to these men to whom the world owes so much.

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Company Contributions to the Progress of Aeronautics

1932–1942

Aircraft Manufacturers

Aeronca Aircraft Corporation 39
Bell Aircraft Corporation 41
Bellanca Aircraft Corporation 43
Boeing Aircraft Company 45
Brewster Aeronautical Corporation 47
Consolidated Aircraft Corporation 49
Curtiss-Wright Corporation 51
Douglas Aircraft Company, Inc. 55
Fairchild Engine & Airplane Corporation ... 57
Fleetwings, Inc. 59
The Goodyear Tire & Rubber Company 61
Grumman Aircraft Engineering Corporation 63
Kellett Autogiro Corporation 65
Lockheed Aircraft Corporation 67
The Glenn L. Martin Company 68
North American Aviation, Inc. 71
Northrop Aircraft, Inc. 73
Piper Aircraft Corporation 75
United Aircraft Corporation 77
Vultee Aircraft, Inc. 79

Engine Manufacturers

Allison Division, General Motors Corporation 81
Curtiss-Wright Corporation 51
Fairchild Engine & Airplane Corporation ... 57
Jacobs Aircraft Engine Company 83
Menasco Manufacturing Company 85
Packard Aircraft Engine Division, Packard Motor Car Company 86
United Aircraft Corporation 77

Air Transport Companies

American Airlines, Inc. 91
Braniff Airways, Inc. 93
Eastern Air Lines, Inc. 95
Mid-Continent Airlines, Inc. 97
Pan American Airways System 99
Transcontinental & Western Air, Inc. 101

Material and Equipment Companies

Allegheny Ludlum Steel Corporation 103
Bendix Aviation Corporation 105
The BG Corporation 107
Curtiss-Wright Corporation 51
E. I. du Pont de Nemours & Company 109
Fairchild Engine & Airplane Corporation ... 57
Freedman-Burnham Engineering Corporation 111
General Electric Company 113
The B. F. Goodrich Company 117
The Goodyear Tire & Rubber Company 61
W. & L. E. Gurley 119
The International Nickel Company, Inc. 121
Walter Kidde & Company, Inc. 122
Kollsman Instrument Division, Square D Company 125
Lear Avia, Inc. 127
New Departure Division, General Motors Corporation 129
Norma-Hoffmann Bearings Corporation 131
Pump Engineering Service Corporation Division, Borg-Warner Corporation 133
The Pure Oil Company 135
Puritan Compressed Gas Corporation 137
RCA Manufacturing Company, Inc. 139
Republic Steel Corporation 140
John A. Roebling's Sons Company 143
Simmonds Aerocessories, Inc. 145
SKF Industries, Inc. 147
Socony-Vacuum Oil Company, Inc. 149
Sperry Gyroscope Company, Inc. 151
Thompson Products, Inc. 153
United Aircraft Corporation 77
United States Rubber Company 155
Westinghouse Electric & Manufacturing Company 157
Weston Electrical Instrument Company 158

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Institute of the Aeronautical Sciences

The First Ten Years, 1932–1942

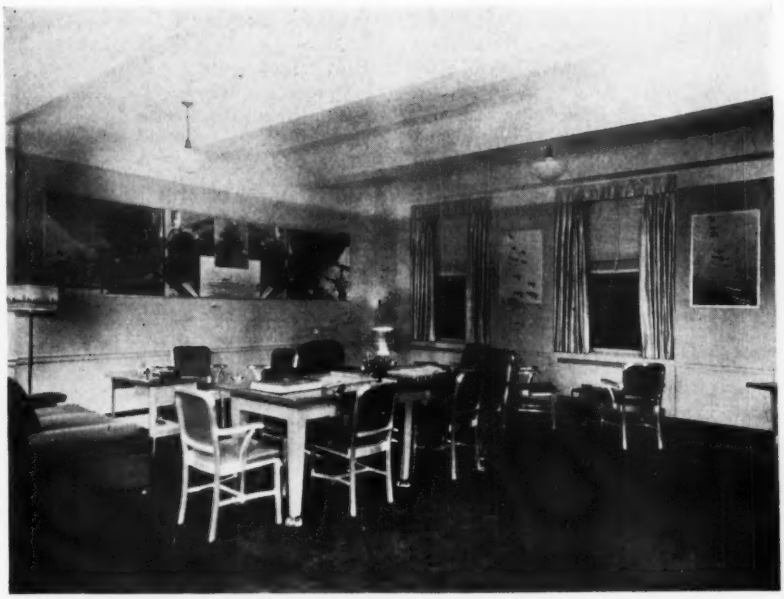
Neither the Institute of the Aeronautical Sciences nor any other successfully developed undertaking has ever been started without much thought, discussion and planning. The Institute came into being October 15, 1932, the date of its certificate of incorporation, because a few men had imagination and foresight, together with no small amount of courage, which is also seen as a factor when one recalls the depressed state of world and national affairs and of American aviation ten years ago.

Assistance from the R.Ae.S.

The first record in the Institute's archives of these preliminary steps is of correspondence in 1928 which Dr. J. C. Hunsaker and Lester D. Gardner had with the Royal Aeronautical Society of Great Britain. They had asked advice of the Society, founded in 1866 and venerable among aeronautical organizations, as to the methods of its operation, its membership and its relation with other aviation societies in England.

On their visits to Europe, Dr. Hunsaker, Mr. Gardner and others had often noted the function served by the R.Ae.S. in England and similar societies in other countries in representing the technical aeronautical profession. Through them they were able to meet the leaders in aviation, and they saw how these organizations provided for their members a forum for the discussion of scientific and engineering problems of aeronautics, a channel for disseminating needed information, a means of giving recognition to individual achievement in the field and how they served to advance aeronautical science and engineering. The lack of such an organization in the United States had been felt and often commented on.

Colonel Sempill, then President of the Royal Aeronautical Society, and Capt. J. Laurence Pritchard, Secretary, furnished information on the function and organization of the R.Ae.S. In fact, Captain Pritchard has been so generous with needed advice and aid from the time of these preliminary moves to the present that he can be considerd as at least a godfather of the Institute. So many similarities were found in the needs served by the R.Ae.S. and those felt here that the Institute's organization has been able to follow to a great extent the pattern so successfully used by the older society. The place occupied by a scientific and engineering aeronautical society in the aviation activities of a country were clearly pointed out in this early correspondence with the R.Ae.S. It was similar both for England and the United States and still holds true. Aero Clubs dealt with private flying and aviation as a sport, a national organization existed for the popularizing of aviation and the promotion of national air-mindedness, another served as a national representative of the aviation industry, and the scientific society served the needs of all those concerned with the technical advancement of aeronautics. Before 1932, the United States lacked the last-named organization. It was to overcome this deficiency that steps were taken to found a society that would embrace all the sciences and technologies applied to aviation.



Institute of the Aeronautical Sciences—1933.

Decision to Form the I.Ae.S.

In late September, 1932, Dr. Hunsaker and Mr. Gardner met to consider again the plans for an organization that had first been suggested five years before. At that time many with whom it had been discussed said that the time was not propitious and that the aviation industry was not well enough established to warrant the formation of a new organization. But they resolved to revive the idea and in the next few days discussed it with Charles L. Lawrance, Grover Loening, E. E. Aldrin, Earl D. Osborn and Edward P. Warner, who, in turn, discussed it with others.

On October 3, Messrs. Aldrin, Gardner, Hunsaker, Lawrance and Osborn met for dinner at the Yale Club in New York. They reviewed the proposals for the organization and concluded that the reception given to the plan had been favorable enough to warrant action. At this meeting, the decision was made to proceed with the incorporation of a scientific society and consult further with prospective members as to a more comprehensive statement of purposes, methods of operation and rules for membership.

Mr. Warner supplied the next important item—the name for the new organization. It was he who suggested "Institute of the Aeronautical Sciences," which met with the instant approval of the organizers and was approved by the New York Secretary of State as not conflicting with any other corporate title.

Certificate of Incorporation

The first draft of incorporation papers was drawn on October 10 and the final papers were signed on October 14. Justice Louis A. Valente of the State Supreme Court approved the papers the same day. On October 15, 1932, Mr. Gardner took the certificate to Albany and had it filed, incorporating the Institute of the Aeronautical Sciences, Inc., under the Membership Corporations Law of the State of New

York for the purposes stated as follows:

"To advance the art and science of aeronautics; to publish works of literature, science and art for such purpose; to do all and every act necessary, suitable and proper for the accomplishment of any of the purposes or the attainment of any of the objects or for the furtherance of any of the powers hereinbefore set forth, either alone or in association with other corporations, firms or individuals and to do every other act, thing or things, incidental or appurtenant to or growing out of or connected with the aforesaid science or art, or powers or any part or parts thereof, provided the same be not inconsistent with the laws under which this corporation is organized or prohibited by the laws of the State of New York."

The Institute was born.

Temporary Organization

The incorporators met immediately after and elected a temporary Board of Directors of twelve members, as provided in the charter, and temporary officers from among these, all to serve until the first Annual Meeting of Members of the Institute.

The Board of Directors was called the Council and consisted of the following: Messrs. Aldrin, Hunsaker, Lawrance, Loening and Warner and Dr. J. S. Ames, Col. V. E. Clark, J. H. Doolittle, George J. Mead, Dr. Clark B. Millikan and T. P. Wright.

Officers elected were Dr. J. C. Hunsaker, President; Grover Loening and Edward P. Warner, Vice-Presidents; Charles L. Lawrance, Treasurer; and Lester D. Gardner, Secretary.

In the first public statement on the Institute, issued just after its incorporation, President Hunsaker said:

"The purpose of the Institute is to advance the aeronautical sciences. Aeronautics in its various activities embraces many different branches of science. The Institute will supplement the work of other organizations that have to do with the industrial, sport and engineering phases of flying.

"The future development of aircraft will come from scientific research, invention and design. The Institute will bring together, for the exchange and discussion of aeronautical problems, scientific experts now engaged in many fields. An immense amount of invaluable aeronautical scientific work is being done here and in many countries. It is from the study of aerodynamics, meteorology, metallurgy, fuels, thermodynamics, and many other fields that the technique of the aircraft industry will advance. The Institute will provide an organization for the encouragement and dissemination of such scientific activity."

Those who have been associated with the Institute for any length of time know that the greater part of the organizational work that followed was done by Mr. Gardner. The office of the Institute in that period was located at his home in New York. A Constitution and By-Laws were drawn up, plans were made for the First Annual Meeting or Founders' Meeting to be held in January, and invitations were sent to a list of about 600 scientists, engineers and others engaged in aeronautical work both in the United States and abroad, to form the founding membership of the Institute.

The Founders' Meeting

By January, 1933, over 400 persons had accepted membership and been classified as Scientific Members, Engineering Members, Pilot Members or Industrial Members. These were called to the Founders' Meeting held at Columbia University in New York on January 26. Arrangements for the use of facilities at Columbia were made through the kindness of Prof. George B. Pegram, Dean of the Department of Physics. The morning and afternoon sessions were held in the same auditorium in the Physics Building, which has become so familiar to members who have attended subsequent Annual Meetings. The hospitality of Columbia University has continued through the years and the Institute has been its grateful guest for every Annual Meeting since then. In welcoming the members of the Institute to Columbia on behalf of President Nicholas Murray Butler, Professor Pegram said:

"It is interesting to us to see this new society, devoted to the scientific rather than the commercial aspects of aeronautics, having its first meeting at Columbia University. This University has been the founding place of a number of important societies. The great American Chemical Society was founded here, as well as the American Mathematical Society, the American Physical Society—which had its organization meeting here in 1899—and others. We look forward sincerely to seeing the history of this society, when it has unfolded, become at least parallel with these others."

First Technical Meeting

The lectures at the First Annual Meeting touched on a wide range of subjects relating to aviation, as they have at all subsequent meetings. Dr. J. H. Kimball spoke on meteorology in relation to transatlantic flying, J. H. Doolittle on test flight data obtained from airplane racing, Dr. George W. Lewis gave a résumé of aeronautical research in 1932–1933, Edward P. Warner spoke on the application of science to design, Prof. C. F. Taylor reviewed recent progress in aircraft engine design, Prof. Auguste Piccard presented data on his stratosphere balloon flights and also gave a popular illustrated lecture on the same subject that evening under the auspices of the Institute at the McMillin Theatre of Columbia University.

First Business Meeting

At the business meeting of Members, which corresponded to the first stockholders meeting of a corporation, the temporary Council members named above, to which was added Dr. J. H. Kimball, were all duly elected to terms of one, two and three years to form the Institute's first Council. The Council then re-elected from among its members the same temporary officers to serve as officers of the Institute for one year.

A Constitution and By-Laws, draft of which had previously been sent to all Members, was adopted, thus completing all the steps necessary to establish the Institute as a membership society.

The Treasurer's report showed receipts of $1,545 from dues of members, accounts receivable of $465 and total expenses of incorporation, organization, printing and postage amounting to $483.84, leaving a balance of $1,526.16, of which over $1,000 was cash on hand and in the bank. The sound financial policy of the Institute started from a good foundation. The Secretary gave his report on membership showing an enrollment of 408 Founder Members.

At the Columbia University Faculty Club that evening, the Institute held its first social function in the form of a reception and dinner, the forerunner of the Annual Dinners and Honors Night Dinners that have been held each year since.

First Headquarters and Activities

In the year following the Founders' Meeting, great strides were made in developing the Institute as an active organization. Most of its present-day activities had their beginning in this period, and each of them has been associated from the start with contributions from those who had confidence in the worth and future of the Institute.

Publication of Proceedings

The first publication, the Proceedings of the Founders' Meeting and Membership List, appeared in book form in June, 1933, and was distributed to about 1,500 individuals, aeronautical centers and libraries all over the world.

By the end of the year the membership of the Institute had increased to 655. A new grade of Technical Member was provided to include the younger aeronautical engineers and technical men. No solicitation of members was made following the original Founder Members invitation list or at any time thereafter. From then on applications were accepted without prior invitation and were placed before the Council's Admissions Committee, which decided upon each applicant's eligibility.

Since the growth in membership made apparent the immediate necessity to start a periodical publication for papers submitted by members and presented at meetings, definite arrangements were made to issue the Institute's first official magazine—Journal of the Aeronautical Sciences.

Official Seal

In the new magazine appeared the first published reproduction of the Institute's official insignia, which was adopted after a contest held for the submission of appropriate designs. Out of the 46 submitted, the honors went to Dr. George W. Lewis of the N.A.C.A. and W. S. Simpson of the Navy Bureau of Aeronautics, the official seal being made of a combination of features of both their designs. The center of the seal is a conventional representation of airflow over the "perfect streamline shape" which the cautious historian, with an eye to things to come, will define as "the cross-section shape of the body offering the least resistance to the flow of air as known to the art in 1933."

The Skyport

For the establishment of the Institute's headquarters in New York, a location for this newest organization in the newest field of transportation was offered in the most recent and modern office building. The RCA building, first and largest unit of the Rockefeller Center development, had just been opened in the late summer of 1933.

At the suggestion of Council member E. E. Aldrin and through the interest of Rockefeller Center, Inc., Mr. Nelson A. Rockefeller, and Mr. Lawrence A. Kirkland, space on the 54th floor of this building was donated for the first year of the Institute's occupancy. Grover Loening donated the furniture and decorating which, together with gifts of aluminum chairs from the Aluminum Company of America, a typewriter from R. H. Fleet and a photomontage mural by Edward J. Steichen, completely equipped a headquarters.

It was christened The Skyport and formally opened on November 20, 1933, at a reception to members and guests. Its aerial view from an elevation of almost 600 ft. over midtown and lower Manhattan and its attractive aeronautical decorations drew the admiration of many visitors as well as members who found it a convenient meeting place.

Since the arrival of the Institute as the first aeronautical tenant, Rockefeller Center has become an aviation center housing the offices of numerous other aeronautical organizations and companies. The Institute outgrew The Skyport after a few years and has twice moved to larger space within the building, first to the 51st floor in 1937 and in 1940 to its present quarters where it occupies over half of the 15th floor in the west end of the RCA Building. In both these moves the management of Rockefeller Center was most generous in making available accommodations suitable to the needs and resources of the Institute.

Headquarters Activities

The collections that later developed into the Institute's great libraries and archives had their beginning with the opening of this first headquarters. Several models and trophies donated were included in the original decorative scheme and the library was started with several hundred aeronautical books given by Mr. Gardner. These were quickly augmented by gifts from other members and by books received for review in the new magazine.

The first permanent, full-time staff to assist the Secretary in the operation of the growing organization was obtained soon after the establishment of headquarters. It consisted of C. E. Sinclair, now Secretary of the Institute, and George R. Forman, now Assistant Treasurer and the Editor of the Aeronautical Engineering Review.

The Officers and Council held frequent meetings to establish policies that were reported to the Second Annual Meeting in January, 1934. As a result of experience gained in the first year of operation, it was recommended that in future elections the composition of the Council be changed so that as many of its members as possible would be from the vicinity of New York to insure quorums at meetings and expedite action on decisions.

In order that the direction of the Institute might have a wider representation from all regions and all branches of aviation, changes in the Constitution and By-Laws were made to permit the election of Officers from among other than Council members and the election of an Advisory Board of twenty members to guide the policies of the Council.

Second Annual Meeting

At the Second Annual Meeting, Charles L. Lawrance was elected President for the next year. From this time on, the various activities that were started in Dr. Hunsaker's year as first President developed to such a great extent that they can be best described separately. Each had its beginning in an idea conceived to fulfill an expressed need of the aeronautical profession; each was fostered to a successful stage of development under the leadership of one or more of the succeeding Presidents and, in the case of most of the projects involved, special gifts or special aid from organizations and individuals provided the means for the phenomenal growth the Institute has experienced in a short ten years.

Gifts from Benefactor Members include $10,000 from R. H. Fleet, and donations of $1,000 each made during the Institute's organization period by George J. Mead, Glenn L. Martin, Donald W. Douglas, Sherman M. Fairchild, E. L. Cord and Laurance S. Rockefeller.

Awards and Honors

An important function of the Institute has been, from the beginning, to give recognition to achievement in aeronautics and encourage outstanding work in all its related technical fields. Thus in the first Constitution provision was made for the election of "persons of pre-eminence in aeronautics" as Honorary Fellows of the Institute and the election as Fellows of members who had "attained a position of distinction and made notable or valuable contributions

J. C. Hunsaker, First President of the Institute—1933.

in one of the aeronautical sciences or aeronautical engineering."

Honorary Fellowship

At one of its earliest meetings in 1932, the Council elected Orville Wright the first Honorary Fellow of the Institute. His acceptance of this, the first honor conferred by the new organization, indicated the high standards to which it gave recognition. Not more than one person from the United States and one from a foreign country can be elected an Honorary Fellow in any one year. Only 18 members have so far been elected to this grade.

Fellowship

At the end of the Institute's first year, when considerable membership had been enrolled, 23 members were selected by the Council to be the first Fellows of the Institute. None of the Officers or members of the Council at the time were included in this selection and immediately thereafter the rules were changed so that future Fellows and Honorary Fellows could be elected only by the Americans who already held this grade of membership.

Not more than ten American and ten foreign members can be elected Fellows each year. Since these are honors conferred upon aeronautical specialists through nomination and secret ballot by their outstanding colleagues in the profession, they carry great distinction.

Charles L. Lawrance—1934.

Reed Award

The Council's proposal to begin the establishment of awards for special achievements was initially presented to Dr. S. A. Reed of New York, one of the first Fellows of the Institute and noted as the designer of the first practical type of duraluminum aircraft propellers. He agreed to provide an annual award of $250 and certificate of citation and to bequeath a fund of $10,000 for its perpetuation. It was stipulated

D. W. Douglas—1935.

that the recipients were to be chosen by vote of the Fellows and Honorary Fellows. The award was established in December, 1934, and first presented for that year. Since the death of Dr. Reed the following year, it has served as a fitting memorial to his distinguished aeronautical career.

The recipients of the Sylvanus Albert Reed Award have been C. G. Rossby and H. C. Willett (jointly), Frank W. Caldwell, Edward S. Taylor, Eastman N. Jacobs, A. V. de Forest, George J. Mead, Hugh L. Dryden and Theodore von Kármán. It is given annually "for a notable contribution to the aeronautical sciences resulting from experimental or theoretical investigations, the beneficial influence of which on the development of practical aeronautics is apparent."

Sperry Award

In April, 1936, an award in memory of Lawrence Sperry was endowed by

Glenn L. Martin—1936.

Elmer A. Sperry, Jr., Edward G. Sperry and Helen Sperry Lea, his brothers and sister, to be presented annually by the Institute "for a notable contribution made by a young man to the advancement of aeronautics."

An award for young men is an especially suitable memorial to Lawrence Sperry whose aeronautical career, already distinguished at the time, was cut short by his death at the age of 31 while attempting a flight across the English Channel on December 13, 1923.

The Lawrence Sperry Award, consisting of a certificate and an honorarium of $250, has been conferred upon W. C. Rockefeller, Clarence L. Johnson, Charles M. Kearns, Jr., W. Bailey Oswald and Ernest L. Stout. The recipients are chosen by a Board of Award, appointed by the donors, consisting of J. H. Doolittle, Lester D. Gardner, Charles L. Lawrance, Grover Loening, Glenn L. Martin and Elmer A. Sperry, Jr. As in the case of the Reed Award, the Sperry Award is endowed with a fund of $10,000 in U.S. Government

Clark B. Millikan—1937.

T. P. Wright—1938.

bonds to provide the annual honorarium and certificate.

Guggenheim Medal

In 1936 the trustees of the Daniel Guggenheim Medal Fund, which was established in 1928 and had sponsored the outstanding annual award "for notable achievement in the advancement of aeronautics," invited the Institute to participation on the Board of Award equally with the American Society of Mechanical Engineers and the Society of Automotive Engineers, each society being represented by three members chosen for limited terms.

Musick Trophy

Another honor in which the Institute participates is the Musick Memorial Trophy established in memory of Capt. Edwin C. Musick and six companions in the "Samoan Clipper" who were lost in the South Pacific on the first commercial flight from the United States to New Zealand, on January 12, 1938. Shortly after that date the citizens of Auckland, New Zealand, subscribed to the creation of the trophy for annual award within the United States and the British Commonwealth of Nations to promote safety in the air, with especial regard to transoceanic flying.

The Award Committee requested the cooperation of the Institute and the Royal Aeronautical Society of Great Britain in the selection of recipients. The Trophy remains for a year at a time in the possession of each recipient who also receives permanently a small replica. Since it was decided not to make any more presentations until after the war, this beautiful silver trophy has been left in the custody of the Institute, where it is on display at its headquarters.

George W. Lewis—1939.

Wright Brothers Lecture

The Wilbur Wright Memorial Lecture, which has been given before the R.Ae.S. every year since the first of the series by Sir Horace Darwin in 1913, has long been regarded as a signal honor to the lecturer chosen and has been the vehicle for important contributions to the professional literature.

James H. Doolittle—1940.

It was this example that inspired the Council of the Institute to establish its counterpart in the United States in the Wright Brothers Lecture to be given annually on December 17, the anniversary of the first flight by the Wright brothers at Kitty Hawk. The lecturers are, whenever possible, invited on alternate years from the United States and from a foreign country. The Committee that chooses the Wright Brothers Lecturer each year is composed of those Americans who have given the Wilbur Wright Memorial Lecture before the British society.

Beginning December 17, 1937, the annual Lecturers have been Prof. B. Melvill Jones, Dr. Hugh L. Dryden, Dr. Clark B. Millikan, Dr. Sverre Pettersen and Prof. Richard V. Southwell.

Frank W. Caldwell—1941.

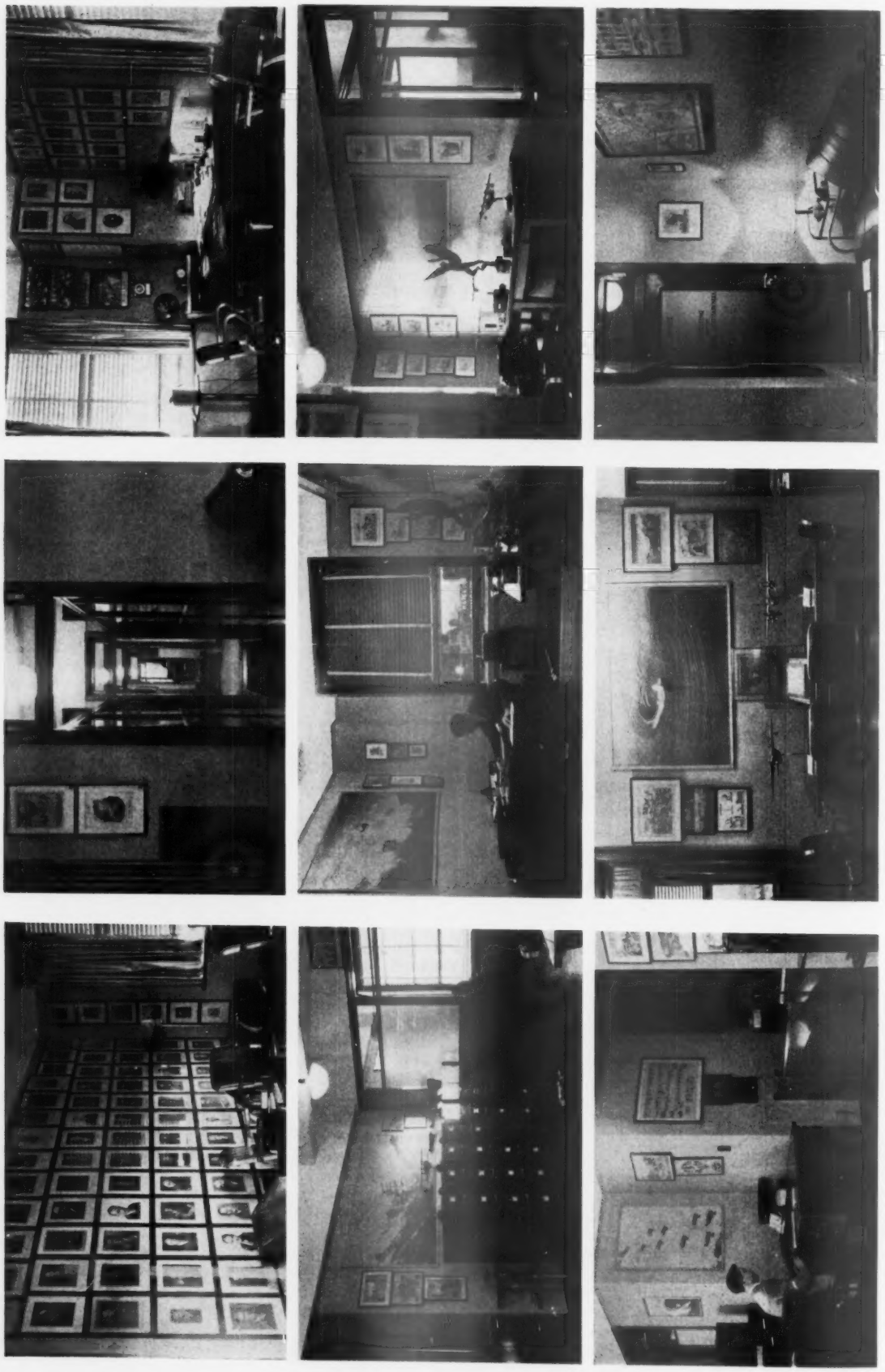
Chanute Award

Continuing a policy of establishing awards to honor pioneers in American aeronautics and to give recognition to achievement in specific subjects, the Institute established an award in 1939 in memory of Octave Chanute, early experimenter with gliders, whose book *Progress in Flying Machines* published in 1884 and other research and personal help encouraged the Wright brothers in their work on powered aircraft.

This award "for a notable contribution by a pilot to the aeronautical sciences" is presented annually to a recipient chosen by the Chief of the Army Air Forces, the Chief of the Navy Bureau of Aeronautics, the Director of the National Bureau of Standards, the Chairman of the Civil Aeronautics Board, the Director of Research of the National Advisory Committee for Aeronautics, and the President and Executive Vice-President of the Institute.

The recipients have been Edmund T. Allen, Howard Hughes, and Melvin N. Gough.

Hall L. Hibbard—1942.



The Executive and General Offices of the Institute. The office of the Executive Vice-President contains over 150 signed photographs of past and present leaders in the aeronautical sciences in the United States and abroad. Aeronautical murals, prints and engravings, models of airplanes and aeronautical trophies decorate the general offices.

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Jeffries Award

A previously little known pioneer was honored the following year with the establishment of the John Jeffries Award "for outstanding contributions to the advancement of aeronautics through medical research." Dr. Jeffries was a Boston physician who in 1785 accompanied the French Balloonist Blanchard, whom he had financed, on the first aerial voyage across the English Channel. He devised recording instruments, took the first scientific observations from a balloon in flight and published a book on his voyages. The design of the Jeffries Award certificate is taken from the frontispiece of this rare and beautiful volume.

It was first presented in 1940 to Dr. Louis H. Bauer and for the following year to Major Harry G. Armstrong. The Committee of Award consists of the Director of Research of the National Advisory Committee for Aeronautics, and the Presidents of the National Aeronautic Association, the Air Transport Association of America, the Aero Medical Association, the Aeronautical Archives and the Institute.

Losey Award

The first loss to the membership of the Institute and to the armed forces of the United States in World War II was by the death of Capt. Robert M. Losey. He was killed at the age of 31 during a bombing raid on April 21, 1940, at Dombas, Norway, while acting as an observer in his capacity as Assistant Military Attaché for the U.S. Legation to Norway and Sweden.

As Captain Losey was an experienced meteorologist and had been a pilot and aerologic officer in the Army Air Corps and, as meteorologic adviser in the Office of the Chief of the Air Corps, had been largely responsible for the organization of the Army's aerologic service, an award was established in his memory to be given annually "in recognition of outstanding contributions to the science of meteorology as applied to aeronautics."

Appointed as a Committee of Award were the Chief of the U. S. Weather Bureau, the Chairman of the Executive Council of the California Institute of Technology, the President of the Massachusetts Institute of Technology, the President of the American Meteorological Society, the President of the Aeronautical Archives and the President of the Institute. The recipient of the Robert M. Losey Award for 1940 was Henry G. Houghton, Jr., and for 1941, Dr. Horace R. Byers.

Student Awards

The Institute has included prizes and awards for aeronautical students. Awards are given every year to two members from each of the Institute's Student Branches and consist of a certificate and an honorarium of two years' prepaid Technical Membership in the Institute upon graduation. The Student Branch Scholastic Awards are given to the graduating students who have maintained the highest scholastic standing in their respective schools, and the Student Branch Lecture Awards are given to those who have presented the best original papers at their Student Branch meetings during the year.

At the beginning of the Civilian Pilot Training Program inaugurated in colleges and universities by the Civil Aeronautics Administration, the Institute received and administered a fund of $15,000 from the Shell Oil Company to hold a contest among all the C.P.T.P. participants for the Shell Aviation Scholarships and Awards. Regional judges and a National Board of Award were appointed, regional contests were held and the finalists competed at Washington, D.C., in August, 1940. Scholarship prizes of $1,000, $750 and $500 were awarded to the winners, trophies were given to the school and the flight training instructor whose student pilots had the highest record of proficiency, and other prizes were given to regional winners. Over 500 schools participated in this contest which furthered interest in, and enlargement of, the pilot training program.

The Institute takes part in the awarding of the Collier Trophy and has given aid and advice to numerous groups interested in conferring honors and giving aid for aeronautical work. While the awards given by the Institute or with its cooperation are only a part of its function, it is nonetheless an important one that can be increased with great benefit particularly through scholarships and grants in aid for research programs.

Meetings—Sections and Branches

Meetings where new developments may be disclosed and common problems discussed, together with its publication of papers and reports on such subjects for wider dissemination, are the chief functions of a professional society.

Annual Meetings

The Annual Meetings of the Members of the Institute are held in New York on the last Wednesday in January. This time and place is stipulated in the Constitution, as a requirement of its charter, for the presentation of annual reports by the Officers, election of Council and Advisory Board members and the transaction of any other necessary business by the voting members.

Held at the same time are the Technical Sessions of the Annual Meetings, which have become the principal forum in the country for discussion of each year's contributions to the various aeronautical sciences. The reports given provide the basis for a great many of the full length papers appearing in the Institute publications. Each of the ten Annual Meetings, beginning with the Founder's Meeting in 1933, have been held at Columbia University, where two large lecture theaters and other rooms in the Physics Building provide complete facilities for the presentation of technical lectures and demonstrations.

From the modest beginning at the Founders' Day Meeting, the Annual Meetings in recent years have been enlarged to three days of about fifteen sessions, the simultaneously held sessions being so arranged that there may be no conflict of closely related subjects. Among the subjects included are aerodynamics, air transport, aircraft design, materials (ferrous, nonferrous and synthetic), meteorology, physiologic problems, power plants, fuels and lubricants, radio and instruments, rotating wing aircraft, and structures. Specialists in each of these subjects act as chairmen and pass on the acceptability of papers submitted for their sessions.

The Technical Sessions are attended by 700 or 800 aviation specialists from all over the country who make an annual pilgrimage to these meetings to discuss problems with their colleagues and learn of new solutions. Under wartime conditions the meetings are safeguarded by careful advance review to eliminate any restricted material and by limited admission to technical sessions.

Section Meetings

The limitations that war imposes on time and facilities for travel have been solved by greater concentration on regional meetings and the repetition of important sessions in several different localities. However, the holding of regional meetings and activities for local groups of members was begun early in the Institute's development, as would be necessary to serve an industry as large and widely scattered as aviation is in this country.

The first local organization was the Pacific Coast Section formed in December, 1934. Several others were organized and held their first meetings simul-

taneously on October 15, 1937, as an observance of the Institute's fifth anniversary. The following year T. P. Wright, sixth President of the Institute, encouraged the growth and activity of local membership Sections to a great extent and made a tour of their meetings.

In Los Angeles, San Diego and Seattle, the Sections are closely identified with local aviation activities and hold frequent meetings well attended by a large body of local Affiliates as well as Members of the Institute. Numerous meetings of larger scope have been held in Los Angeles, including the Institute Summer Meetings of several sessions held as interim Annual Meetings. The Section in Philadelphia, center of activity in rotating wing aircraft, has organized meetings on this subject. Sections have been active in San Francisco, Dayton, and Notre Dame, Ind. The first of the series of meetings of the Section in Detroit in its 1942 season was the largest gathering ever held in that city by any technical society, being attended by over 1,700 persons.

These local activities are initiated and carried out, for the most part, by members in these regions with assistance from the national office. The chief limitation has been lack of sufficient funds for this specific purpose, but it is hoped that at this beginning of the Institute's second decade this type of activity, which is so vital at the present time, can be enlarged.

Student Branches

The Institute turned its attention to the needs of students in aeronautical engineering schools and colleges soon after its organization. A grade of Student Membership was provided in 1935 and Student Branches were formed in several colleges in the Fall of that year. The tremendous interest and enthusiasm among the members of Student Branches was especially noted by President Doolittle when he and Mr. Gardner made a series of visits in the Spring of 1940 to Institute Student Branches at 31 schools all over the country and addressed their meetings.

There are now 40 Branches and their activity is indicated by the numerous reports published each month in the Institute's magazines. The first Midwest Student Branch Regional Meeting was held at the University of Notre Dame in March, 1942, and was so successful that similar regional conferences will be held in following years. Speakers, motion pictures and lecture material for meetings are provided by the Institute without cost to the Branches. No fees for Student Membership are charged by the Institute, dues being levied only by Student Branches for their own expenses. Enrolled Student Members are entitled to subscribe to all Institute publications at reduced rates.

The Officers and Council feel that the contribution made through Student Branches is aid given to the aeronautical engineers of the future at a time when it is of most benefit to them. The interest aroused among engineering students in their representative professional society leads many of them to join the Institute as Technical Members when they graduate and take their places in aviation work.

Medal Presentation

The Institute's first large and formal social affair was the dinner meeting held at the Biltmore Hotel in New York on December 4, 1936, for the presentation of the Daniel Guggenheim Medal to Dr. Lewis. It was held in cooperation with the A.S.M.E. and the S.A.E., by whom the award is conferred jointly with the Institute. It had an international scope through official greetings expressed by the Air Attachés of foreign countries and by the presentation at the technical meeting preceding the dinner of motion-picture films especially prepared for the occasion which showed the aeronautical research laboratories of England, France, Italy and Germany.

International Exchanges

American aeronautical experts, as members and officers of the Institute, were shown exceptional courtesies, when traveling abroad, by equivalent societies and aviation officials. The Institute was frequently host at special functions honoring foreign visitors, such as dinners and lecture meetings for eminent members of the Royal Aeronautical Society of Great Britain and the reception and meeting held with other organizations for the Russian transarctic flyers who established a world's long-distance record in July, 1937.

The Institute assisted in organizing the sessions of the Fifth International Congress of Applied Mechanics held at the Massachusetts Institute of Technology in September, 1938. Many new contacts with foreign aviation specialists were made at this meeting and out of discussions with them grew the plan for the holding of an International Congress of the Aeronautical Sciences by the Institute the following Fall at the time of the New York World's Fair.

The response from abroad to invitations issued was overwhelmingly favorable and indicated the high regard in which the Institute was held in all countries. However, reports of American members returning from Europe had begun to indicate a more and more ominous trend behind much of the European aeronautical expansion.

When President Lewis and Mr. Gardner were in Europe in May and June of 1939 they noted signs of impending trouble. They visited England, France, Germany, Italy, Holland and Norway and on their return the Council of the Institute accepted their recommendation that the plans for the international congress be postponed indefinitely. By September, on the date that had originally been set for the meeting, the first campaigns of World War II were already on in full fury.

From this time on, international relations became exchanges of mutual aid with allies and potential allies in defense. The activities of the Institute and all the aeronautical profession of this country were directed toward the problems of national defense which they had so well foreseen.

Wright Brothers' Lecture Meetings

With the inauguration of the Wright Brothers' Lecture on December 17, 1937, the Institute held the first of its Honors Night meetings which have become the outstanding annual social events in aviation. The Guggenheim Medal, Reed Award, Sperry Award, and Fellowships, Honorary Fellowships and Honorary Memberships in the Institute were presented.

Attending the meeting as a guest of Council member Sherman M. Fairchild was Edmund C. Lynch of New York. He noted the mention made by President Clark B. Millikan in his opening address of the need for an endowment for the Wright Brothers' Lecture and discussed the matter with Mr. Fairchild. By the end of the month he had sent the following letter to the Institute:

"So strongly am I of the opinion that the Wright Brothers' Lecture will bring disclosures of advances which will be of practical benefit to aviation, that I believe the Institute should continue this work. With this in view I desire to make a contribution to the Institute, the principal of which is to be held intact and the income therefrom applied annually toward the accomplishment of this purpose. This contribution is in commemoration of my brother, Mr. Vernon Lynch."

The gift of the Vernon Lynch Fund of securities valued at $10,335 has enabled the Institute to give an honorarium of $250 for the Wright Brothers' Lecture each year, defray the traveling expenses of foreign lecturers and hold a suitable ceremony to mark the December 17 anniversary.

Honors Night Dinners

The Honors Night Dinners have since become notable occasions in conjunction with each Annual Meeting. The programs, in which all the Institute

awards and honors are presented and the Institute presidents inaugurated, attract the outstanding leaders and officials in American aviation.

The Institute has held numerous other special meetings, such as air transport meetings in Chicago and aeronautical sessions at the meetings of other societies, particularly the American Association for the Advancement of Science, of which the Institute is an affiliated society.

The growth of the Institute's membership in many new aeronautical centers indicates that among its most important immediate needs are the resources and staff for expanding meetings activities in these localities.

Libraries and Aeronautical Archives

As early as 1934 a small library of several hundred books had been given to the Institute by members. In 1935 with the cooperation of the Work Projects Administration, a bibliography of aeronautics was compiled. This index grew until it contained over 2,000,000 cards. Biographies, author indexes, chronologies, book lists, subject indexes, digests, and many other divisions were included in the files. For six years the W.P.A. furnished the workers and much material to make this compilation a most comprehensive index of aeronautics.

From these files the references on 50 of the more important and useful subjects were selected, brought up to date and published in mimeographed volumes. In 1940, supplements to some of the earlier compilations were published. In all, 16,000 volumes were printed and distributed in sets to leading libraries, laboratories, universities and government departments. All this indexing was under the supervision of Robert R. Dexter who has general charge of the present libraries of the Institute and the special service department that renders such valuable assistance to many aircraft companies.

The Burden Library

William A. M. Burden, a member of the Institute, had for many years been collecting aeronautical books until he had assembled what was undoubtedly the finest private aeronautical library in the world and probably second only in its wide scope to the collections in the Library of Congress. Mr. Burden recognized the great advantage it would be to readers if his library could be placed at the Institute so that references found in the Index files could be consulted there immediately. He offered to place this great collection of over 12,000 books, bound magazines, and pamphlets in the custody of the Institute for a long period. By this generous action the Institute became a center for aeronautical reference and research equal to any to be found in the United States.

The Paul Kollsman Library

The reference library enabled the Institute to make available a service to many, but, as books could not be loaned, there was another and equally important service that could be rendered—that of a lending library. Fortunately for the Institute, Paul Kollsman realized that the lending of books, not only to members but to many others, would be of the greatest assistance to young men who could not come to the library in New York. In 1940, he and The Square D Company of Detroit made an initial gift of $50,000 to establish such a lending library. There are over 2,105 members of this library who borrow books regularly. A large proportion of these are not members of the Institute, but all may borrow books without any deposit or fee. Since the library was started, 3,151 books have been loaned by mail.

From the proceeds of this fund the Institute was able to purchase new books, to keep its library collection up to date and to engage experienced librarians and cataloguers. As publishers send newly published books for review in the Aeronautical Engineering Review, the accessions from this source alone are large. This library now has over 7,000 volumes.

In order that there would be a permanent endowment for this service Mr. Kollsman decided to add $25,000 to the gift he had already made so that the Institute has an endowment of $65,000 to maintain the library.

The Pacific Aeronautical Library

In 1941, at the suggestion of the librarians of aircraft companies in the Los Angeles area, the Institute established a branch library in Hollywood. The Institute furnishes the books and equipment for this library and each of the large companies contributes to its upkeep. It now has 1,427 books and 11,500 unbound magazines and is rendering a valued service in cooperation with the loan service from New York.

Other Donors

The list of donors of books to the Institute libraries is large. Outstanding are the gifts of E. E. Aldrin, Clarence D. Hanscom, V. E. Clark, Edward P. Warner, Lester D. Gardner and Mrs. Bella C. Landauer. The National Aeronautical Association, which had received some of the books from the Aero Club of America library, placed them in custody of the Institute. In 1939, C. R. Fairey of London gave $1,000 to purchase books in England for the library. Through this fund many of the latest English aeronautical books have been obtained.

Formation of the Archives

While in Paris in 1939, Dr. George W. Lewis, then President of the Institute, and Lester D. Gardner received an invitation from Hart O. Berg to call and see his collection of early aeronautical papers. Mr. Berg had been the representative of the Wright brothers in Paris during their negotiations with foreign governments and, fortunately, had saved clippings, photographs and pamphlets of that period. He offered them to the Institute and Dr. Lewis brought a trunk full of rare papers back with him to this country.

As some of this material and many other possible gifts would not properly be a part of a library, Mr. Gardner suggested to Dr. Lewis that the Institute might become a repository for many collections, in addition to books, by establishing the Aeronautical Archives of the Institute. The suggestion was adopted by the Council and gifts soon commenced to come from many friends.

The Harry F. Guggenheim Collection

The first collection of prints, etchings and engravings to come to the Aeronautical Archives was from Harry F. Guggenheim. These rare and valuable works of art had been procured for Mr. Guggenheim by experts from all over Europe. When they were received, Mrs. Bella C. Landauer, another collector of rare aeronautical prints, was requested by the Institute to give her expert advice in cataloguing the collection.

The Landauer Collections

Becoming acquainted with the purposes of the Institute and the facilities of the Aeronautical Archives, Mrs. Landauer decided to present her great collection of aeronautical prints to the Archives. By this most generous gift the Institute took its place as owner of one of the great collections of aeronautica in the world. The aeronautical print collection of Mrs. Landauer included not only rare French,

The Aeronautical Archives and Libraries of the Institute. These general views show sections of The Paul Kollsman Library, the Burden Library, the Aeronautical Indexes, and reading room. The walls of the reading room are hung with famous prints and engravings from the Harry F. Guggenheim collection. Models of historical airplanes, rare trophies, and medallions are on exhibit. Two special bookcases, one of which is shown above, contain a collection of rare books on aeronautics dating back to the year 1600.

English, German and Italian engravings but hundreds of American original drawings, book plates, photographs, trade cards, posters, and portraits.

Aeronautical Music

In addition to the above Mrs. Landauer has continued to bestow gifts from her collections. Her collection of aeronautical sheet music from many countries is unique so far as is known. The 1,500 items contain music dated as early as 1796 and hundreds of compositions written in the nineteenth century. The value of this collection is enhanced by the lithographs on the covers. From them the history of aeronautics can be traced.

Medals and Medallions

Mrs. Landauer also had a priceless collection of medals and medallions which now belong to the Aeronautical Archives. To these L. D. Gardner, A. P. Loening and Charles L. Lawrance have made additions, and many air lines presented insignia worn by their flight personnel.

Models and Curios

Starting with a few models presented by American companies, the airplane model collection was added to by gifts from English, German, Italian and French constructors so that the Archives has now over 100 models of airplanes of many different types.

From time to time gifts were made to the Archives of relics and curios having an aeronautical interest. Mr. Orville Wright gave a piece of the fabric of the Kitty Hawk plane. Mr. Charles L. Lawrance presented a model of one of his early engines which was made by Cartier's craftsmen. This collection was comparatively small until Mrs. Landauer again decided to enlarge this part of the Archives. Rare and curious objects that she had been buying for many years were given to the Institute. Sets of porcelain plates with historical aeronautical designs, tiles similarly painted, aeronautical clocks, aeronautical jig saw puzzles made over 100 years ago, miniatures, porcelain powder boxes; fans, rings and innumerable other curios having an aeronautical interest are now on display at the Institute.

Feeling that the Archives might as well have the entire collection she had made, Mrs. Landauer gave hundreds of rare aeronautical books, pamphlets and dime novels. Some of these books are the rarest of collector's items and of great value. She bought everything she could find having to do with early American Aeronautics. A collection of 60 children's books containing references to aeronautics is of especial interest. The Aeronautical Archives now has a most complete collection of Aeronautica Americana.

During March, 1942, an exhibition of some of the prints, posters, and medallions from the Institute's collection was held at the University Club in New York. On exhibition at the Institute are many trophies. The Musick Trophy, The Pulitzer Trophy, The Rickenbacker Trophy, The Gordon Bennett Trophy and others are among those seen by visitors.

The owners of several other collections in the United States are considering placing them in custody of the Institute. The Archives welcomes additions to its collections from members and friends.

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Institute Publications

Journal of the Aeronautical Sciences

The Journal of the Aeronautical Sciences, first official publication of the Institute, has been esteemed highly by the Aeronautical profession from its first issue in January, 1934. It has fulfilled an important need ever since through its publication of technical reports on the aeronautical aspects of advances in many sciences and branches of engineering. Papers read at meetings of the Institute are presented in full or in condensed form for the benefit of all members on new knowledge in physics, structures, metallurgy, meteorology and other subjects. Each issue contains a few complete professional papers and a number of shorter notes and critical comments.

Every paper submitted for the Journal is carefully reviewed by members of the Editorial Board who are specialists in the field it concerns. On the judgment of the Editorial Board depends the decision as to the suitability of each paper for publication. Dr. J. C. Hunsaker served without compensation as the Journal's first Editor until July, 1941, when his new duties in the chairmanship of the National Advisory Committee for Aeronautics and other wartime responsibilities made it impossible for him to devote the necessary time to the Journal. He was succeeded by Dr. Hugh L. Dryden, Chief of the Mechanics and Sound Division, National Bureau of Standards. The editorial excellence that has been maintained through their careful and discriminating supervision has brought to the Journal of the Aeronautical Sciences recognition as one of the leading scientific magazines of the world.

The Journal was published quarterly for the first year, then as a bimonthly in 1935. Since January, 1936, it has been published monthly.

Corporate Membership

Since a magazine like the Journal with quantities of mathematical material, tables and illustrative figures, is expensive to print, the Institute depended from the beginning on the aviation industry to support the publication. This was done by advertising until March, 1936, when it was discontinued and the Journal was supported entirely by Corporate Membership dues.

This arrangement had been started, in the preceding year, at the suggestion of the heads of several companies who preferred to contribute to the Institute directly through the payment of dues for company memberships. The plan was fostered by President Glenn L. Martin during his term of office in 1936, and now there are 80 companies in the aviation industry or allied enterprises which are affiliated with the Institute. As Corporate Members they receive special services and are listed on the "Appreciation Page" in each issue of the Journal.

This continued support has enabled the Institute to render to its members services that would be possible only in a small part from the income from individual membership dues. The contributions from nearly all the important units of the industry have played an enormous part in the Institute's progress. The confidence in its future and high evaluation of its worth which is thus expressed indicate the industry's widespread recognition of the Institute as the representative technical society for American aviation.

Aeronautical Readers Guide

When the fund establishing the Paul Kollsman Library was given to the Institute, one of the specific requests of the donors was that part of the fund be used for publications to facilitate the use of the library and keep readers abreast of current literature in aviation. The first such publication was the Aeronautical Reader's Guide issued in September, 1940, and the three following quarterly periods. It contained titles and brief digests of aeronautical books classified by subject and arranged in suggested reading lists. A fundamental aeronautical bibliography was thus provided and by listing all the books in The Paul Kollsman Library at the time, it acquainted members with the material available and encouraged a widespread and intelligent use of the lending service.

In its issue of November, 1935, the

JOURNAL OF THE AERONAUTICAL SCIENCES had commenced the publication of an "Aeronautical Review" department, which contained digests of current articles from aviation and technical periodicals. The following year this department was enlarged through the cooperation of the Army Air Corps, which permitted the JOURNAL to publish its monthly "Technical Data Digest." Together with the regular book reviews, it became one of the most valuable and highly regarded services of the Institute.

AERONAUTICAL ENGINEERING REVIEW

The Kollsman Fund offered an opportunity, which the Officers and Council were quick to appreciate, to expand this service by including reviews of all aeronautical books, digests of popular as well as technical aviation articles, reviews of government publications and releases and digests of industry news. It appeared as the first issue of the "Aeronautical Review" published in November, 1940, as a separately bound section of Vol. 8, No. 1, of the JOURNAL OF THE AERONAUTICAL SCIENCES and was sent to all members and subscribers at no increase in dues or subscription rates. It was also published as a separate edition so that nonmember subscribers could obtain this section alone. The magazine filled a real need in supplying a concise and complete coverage of the current literature as needed by busy people in a rapidly growing wartime industry.

Support from advertising increased as advertisers realized the highly selected nature of its circulation. In April, 1942, the title AERONAUTICAL ENGINEERING REVIEW was adopted. George R. Forman was made Editor and Robert R. Dexter, Managing Editor. They and Bennett H. Horchler, Manager, deserve credit for their work on the staff in building up the REVIEW from its beginning.

The change in title also signified another enlargement in scope. In addition to reviews and digests, the AERONAUTICAL ENGINEERING REVIEW had begun the publication of original papers on aircraft production methods and applied engineering. This feature is constantly being enlarged. The news of Institute activities, formerly published in the JOURNAL, was also added as a department of the REVIEW, thus providing space in the JOURNAL for the more complete and prompt appearance of the scientific papers and research reports, which it continues to publish.

FAIRCHILD PUBLICATION FUND

The Institute has also issued special publications from time to time. The 50 parts of the BIBLIOGRAPHY OF AERONAUTICS, already mentioned as published with funds allocated by the W.P.A., were distributed by the Institute after publication under its editorial supervision.

In December, 1941, Sherman M. Fairchild donated a fund of $25,000 to be used for the publication of works that might be either too large or too specialized for the Institute's magazines but yet of sufficient importance to aviation to warrant their issuance as separate publications, even though for limited or restricted circulation. One such publication has already been issued and another is in preparation. It is expected that the Sherman Fairchild Publication Fund will enable the distribution of a number of important specialized reports or compilations that could not otherwise be made available.

The Guggenheim and Martin Gifts

When President Donald W. Douglas announced at the Fourth Annual Meeting in 1936 that an anonymous donor had informed him that he had made provision in his will for an eventual bequest to the Institute amounting to about half a million dollars the members realized that the society had achieved a high standing and esteem and that its development on a much larger scale in the distant future was assured.

However, two great gifts made in 1942 by Mrs. Daniel Guggenheim and Glenn L. Martin have brought in the Institute's tenth year the means for developments that no one would have imagined possible for decades to come.

DANIEL GUGGENHEIM PARK

In June, 1942, Mrs. Daniel Guggenheim informed the Institute through her son, Lt. Comdr. Harry F. Guggenheim, of her desire to donate her estate for its use. In her letter proposing this gift she wrote:

"I hereby offer to the Institute of the Aeronautical Sciences, Inc., my property near Port Washington, Long Island, comprising about one hundred sixty acres with two-thirds of a mile of waterfront on Long Island Sound.

"The buildings now on the property can be put to immediate use for laboratories, libraries and other purposes of the Institute.

"Obviously, I am no specialist in the art or science of aeronautics, but for a score of years aviation has been a familiar subject of discussion in my family life. No cause challenged more keenly the interest of my husband or my son, Harry. As you know, my husband, after mature study, founded the Daniel Guggenheim Fund for the Promotion of Aeronautics and my son, Harry, was its active President. Their enthusiasm was contagious, and I caught it, though not having their thorough knowledge.

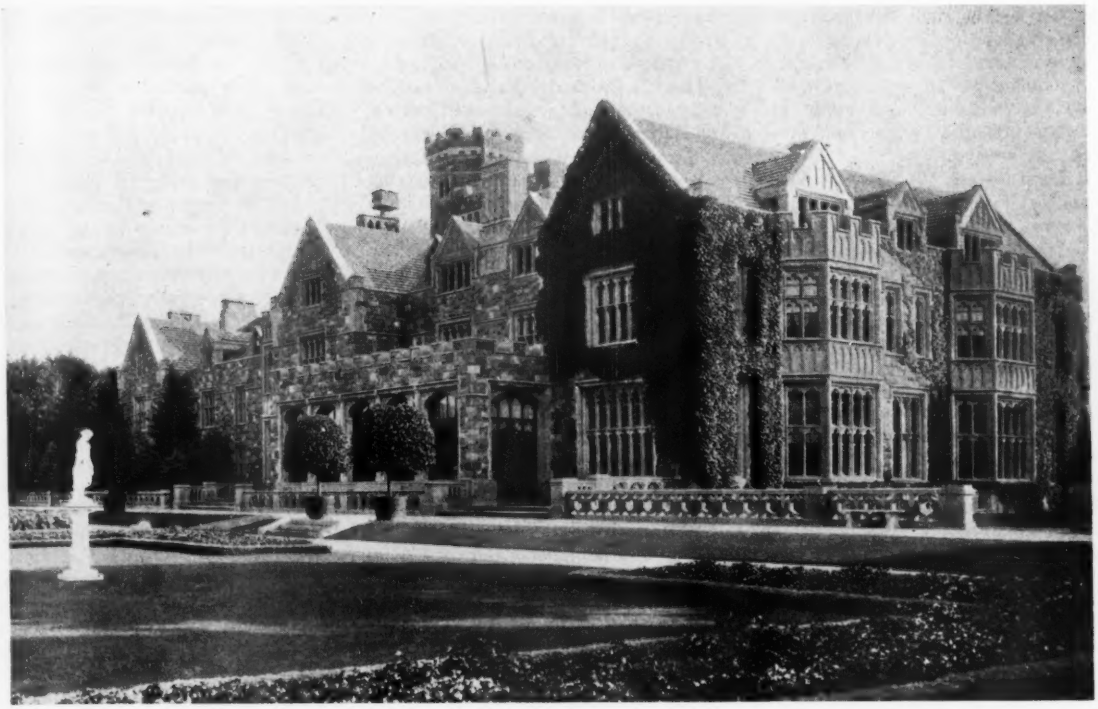
"It seems that my Long Island property meets the needs of the Institute for a location for its scientific projects. I know it would delight my husband, were he still living, again to render a service to aviation. Now, in his stead and memory, I have the privilege of making this offer."

MINTA MARTIN FUND

In view of this generous proposal and after discussion with the officers and Council as to the ways in which the Institute could use the estate for the advancement of aeronautics and as an immediate contribution to the war effort, Glenn L. Martin offered to the Institute an endowment of securities having a value at the time of over $450,000 for use in conjunction with the Guggenheim property. In his formal letter of gift he said:

"I have carefully reviewed your plans for expanding your usefulness during the war emergency and thereafter through the acquisition of the Sands Point estate of the late Daniel Guggenheim and establishing thereon an effective laboratory, and I am in thorough sympathy with such a program.

"I understand that Mrs. Daniel Guggenheim has offered to donate to you the unrestricted title to and ownership of the Sands Point property comprising the Guggenheim estate recently occupied by her and her husband, the late Daniel Guggenheim, upon condition that, coincident with such donation, I effectively agree to donate to you, during the five years 1942–1946, 25,000 shares of the capital stock of The Glenn L. Martin Company; and, in fulfillment of this condition and in consideration of such donation to you of the Sands Point property, I hereby agree to donate to you in each of such five years 5,000 shares of the capital stock of The Glenn L. Martin Company, as a fund to be known as The Minta Martin Aeronautical Endowment Fund and available to you for any purpose incidental to the maintenance and operation of the Sands Point property so donated to you and the creation, maintenance and development thereon of aeronautical research laboratories to be designated and known as The Minta Martin Aeronautical Laboratories, for the benefit of those persons engaged in aeronautics in the United States or the Government's activities in aeronautics.



The residence on the estate at Sands Point, near Port Washington, Long Island, to be used eventually for the Aeronautical Archives and Library.

"I am making these commitments in commemoration of my mother's sympathetic assistance to and cooperation with me in my aeronautical activities over the past years and as a tangible recognition of my appreciation of your fine cooperation with the development of aeronautics in the past and the unlimited possibilities of your further cooperation in the future."

In accepting these magnificent gifts, which were announced and described fully to members in the July, 1942, issue of the AERONAUTICAL ENGINEERING REVIEW, the Council expressed the appreciation of the Institute and the belief that the resources entrusted to it could be employed for the greatest possible benefit to the aeronautical sciences as indicated in the letters of gift.

It is planned that the immediate use of the property and fund will be for war projects that may necessarily be of a confidential nature. After the war the possibilities are almost limitless in using the ample acreage, the beautiful mansion house and the enormous garage-storehouse and other buildings on the estate for such purposes as aeronautical archives and museum, reference library, and fully equipped scientific laboratories where research projects and fellowships in residence might be established.

Upon receipt of the deed to the Guggenheim property and the Martin Fund, the Institute became one of the most heavily endowed scientific societies in the country. On the basis of the present valuation of all the funds and properties now committed to the Institute's custody for special and general purposes, but not including its library and archives collections, the assets of the Institute amount to about $1,200,000. For the information of any who wish to compute a rate of increase let it be reported that the assets shown on the Institute's first annual financial statement ten years ago were $1,176 and at the end of its fifth year were $23,497.

Membership of the Institute

In the foregoing much has been told *about* the Institute, its purposes, its activities, its tangible and intangible assets; but so far the answer has not been given to the question: What *is* the Institute of the Aeronautical Sciences? The answer is simply—its members. They own its properties, carry out its activities and are, by their unity in one organization, the composite body that has made the progress recorded here and built up the prestige that the name of the I.Ae.S. bears today.

The 400 Founder Members set the original standards for membership and provided for the admission of additional members who met stated requirements and accepted classification in specified grades of membership. Changes in requirements for various grades were made from time to time during the continual growth of membership as experience indicated and in accordance with democratic procedure of approval by direct voting and duly delegated authority. Through the careful review of all applications by the Admissions Committee, the grade of membership held in the Institute by an aeronautical specialist indicates his standing in the profession as judged by education, experience and contributions to the art.

GRADES OF MEMBERSHIP

The various classes of membership and their qualifications are described in the following excerpts from the By-Laws. The membership figures are those of September 30, 1942, the end of the last fiscal year.

"*Honorary Fellows* of the Institute shall be elected by the Honorary Fellows and Fellows of the Institute residing in the United States and shall be persons of pre-eminence in aeronautics."

"*Fellows* shall be proposed and elected by the Honorary Fellows and Fellows of the Institute residing in the United

States. A Fellow shall have been an Associate Fellow for one year or more and have attained a position of distinction in aeronautics. He shall have made notable and valuable contributions in one of the aeronautical sciences or aeronautical engineering."

The Institute has 18 Honorary Fellows and 141 Fellows.

"*Honorary Members* of the Institute may be elected by the Council for the period of one year."

This is an ex officio honor conferred or renewed by the Council each year upon governmental, military and other aeronautical officials. They number 14 at present.

"*Benefactors* shall be those persons who, because of their interest in the advancement of aeronautics, shall have contributed to the Institute the sum of not less than one thousand dollars."

Most of the 18 Benefactors hold another grade of membership in addition to this designation which is conferred to indicate their generosity to the Institute.

"*Associate Fellows* shall have been members for six months or more and ordinarily be over thirty years of age. They shall have been personally responsible for important aeronautical developments. They shall have been actively engaged for a minimum of five years in aeronautical engineering, research, instruction or the application of science to aeronautics or in the aeronautical arts and literature."

There are 434 Associate Fellows. Transfers to Associate Fellowship are made only upon application. Fellows are chosen from this group.

"*MEMBERS* shall ordinarily be over twenty-five years of age and shall be persons who have completed approved courses in engineering and in addition have been engaged in aeronautical work for at least three years; or they shall be persons who have been engaged for at least five years and acquired a recognized standing in aeronautical engineering, design, research, instruction, test flying, the application of special sciences to aeronautics, or the technical development of the manufacture or operation of aircraft, aircraft engines or other essential components or accessories of aircraft. Previous scientific or engineering experience in some non-aeronautical field may be considered as part of the qualification of an applicant for this grade provided it is shown that this experience has contributed to the aeronautical work being done at the time of application."

In this classification of 686 persons are the main body of experienced engineers, research workers and educators in the Institute's membership.

"*Industrial Members* shall ordinarily be over twenty-five years of age and shall be persons engaged in the application or development of aeronautics in an administrative or supervisory capacity who have acquired a recognized standing in the aeronautical industry."

The 164 Industrial Members include many of the most prominent executives and leaders in the aviation industry.

"*Technical Members* shall be former Student Members who have graduated and those persons engaged in scientific or engineering work in aeronautics or fields closely related to aeronautics."

This constitutes the largest grade of members in the Institute, numbering 1,871, since the greater part of the increase in membership in recent years has been made up of recent graduates or young engineers just beginning their aeronautical careers. As they obtain experience they are transferred to higher grades upon application or after periodic reviews of Technical Membership records.

"*Student Members* shall be undergraduate or graduate students attending those universities or schools which have met the requirements of the Institute and which have on their faculties at least one member of the Institute who will recommend them for membership. Student Members shall comply with and be subject to the Rules for Student Membership adopted by the Council."

Student Members maintain activities and are affiliated with the Institute through Student Branches organized in their schools, as previously described. Their memberships are renewed on a yearly basis. The enrollment of Student Members for the school year ending in June, 1942, totalled 1,410.

"*Affiliates* shall be persons who are engaged in aeronautical work or work related to aeronautics who wish to participate in the activities of the Institute and receive the services specified by the Council for this grade of membership."

The provision for Affiliates has recently been made to allow many who are interested in the Institute's activities but not qualified for other membership grades to receive the AERONAUTICAL ENGINEERING REVIEW and attend local meetings. It will include a number who have previously been affiliated with local Institute Sections and participated in their meetings but who were not national members.

"*Corporate Members* shall be manufacturers or operators of aircraft or producers of equipment, services or supplies used in aeronautics who contribute to the Institute of the Aeronautical Sciences dues set by the Council."

The 80 companies that are Corporate Members contribute to the support of the Institute because they value and wish to enlarge the services that it provides to these individual members who comprise their technical staffs and constitute the aeronautical profession.

GROWTH OF MEMBERSHIP

Without any solicitation of new members, the individual membership figures at the end of ten years have grown to 3,327 graded members plus 1,410 Student Members for 1942 or a total enrollment of 4,737 members. The interest of the applicants who steadily increased the enrollment was aroused by their own contact with the Institute activities and publications or through the proposals and recommendations of their colleagues who were already members.

The lapel insignia emblem denoting membership in the Institute is worn by aeronautical men in the aircraft plants, aeronautical laboratories, schools or other organizations in every part of the country. Its simple design—the center figure of the official seal done in gold on black for Honorary Fellows, Fellows and Associate fellows; silver on black for MEMBERS, Industrial Members and Technical Members; gold on white for Affiliates; and silver on white for Student Members—is an emblem that has become familiar in all aviation circles.

Of all the certificates for various honors awarded by the Institute, the one that is most fundamentally significant and most widespread, is the certificate of membership that is displayed in the homes and offices of its thousands of members. It indicates a member's grade in "the Institute founded in 1932 to advance the scientific knowledge and the prestige of the aeronautical profession."

The Future

The progress of the Institute during its first ten years is only an indication of the possibilities that are attainable in the future. Several members have placed in their wills bequests of large amounts that may eventually be available for enlarged activities. The Institute has been organized and operated as an "endowable" society. Every fund entrusted to its care has been kept intact and is larger now than when the gift was made.

The interest of members, the careful administration by the Council and officers and the confidence of donors, present and prospective, will place the Institute in a position to render a greater service to its members, the aeronautical profession and the aeronautical industry.

Aeronautical Research*

JEROME CLARKE HUNSAKER†

National Advisory Committee for Aeronautics

I WELCOME this opportunity to speak of aeronautical research because just now relatively few people are concerned with it.

Our resources are being strained to the utmost to produce aircraft now in immense numbers. While it is undoubtedly true that an airplane now is worth more than ten airplanes next year, it is no less true that a good airplane now may not be good enough next year.

Research is primarily concerned with finding out how to get better airplanes next year. They certainly can be better. Depending on the vigor and imagination applied in research, we have a chance to develop airplanes and their armament and equipment superior to those the enemy will bring against us.

Mass production implies standardization and the freezing of designs that were available when the program was adopted. Since adherence to a program naturally appeals to the vast number of workers and tax payers, politically minded officials, having responsibility for it, will shy away from any thought of change.

However, the enemy will not be so obliging as to continue his attack on us with his present methods and weapons. Nor will he be so obliging as to wait for us to perfect new and better ways to defeat him.

Since the start of active warfare in Europe, the Germans have raised the engine power, the speed and the ceiling of their airplanes. At the same time, fire power, armor and other protection have been notably increased. There is evidence of standardization but on a term basis, with new models appearing at intervals.

The British, largely as a result of continuing research and experiment have met the improved German airplanes with improved British models. But some changes of a drastic nature had to be made as a result of bitter experience.

Last year many exported American airplanes had also to be radically altered as a result of British combat experience. No doubt further interference with orderly production schedules will occur. It is the enemy who forces changes and determines when our airplanes are obsolete.

Many changes do not result from research, but rather from the lack of it; or from lack of foresight of what the enemy can and will do. When military necessity requires immediate action, production men are made unhappy, paper production schedules are upset and there is gross waste of effort and materials. War is essentially wasteful.

To minimize such production upsets is the joint responsibility of research men, aircraft designers and the military services. There must be strict control of design by the fighting services, while at the same time the research laboratories must have early notice of future tactical requirements.

For example, if there be forecast a demand for night fighting, a number of research problems are at once indicated, such as suppression of exhaust flames, problems of night vision, special detection and navigational equipment to assist interception of an enemy in the night sky. A new requirement sets many research groups to work.

Another example might be a demand for fighting at very much higher altitudes. Here a whole array of difficult problems are thrown to the research laboratories. First, there must be improved supercharging of the engine to give lively performance at higher altitude.

Also, the pilot must be protected against the effects of low pressure and temperature and lack of oxygen. Here the physiologist and the airplane designer must collaborate.

Such research problems require time. But there is never time if the problems have not been foreseen. Perhaps our own demands can be foreseen, but problems of painful urgency result from disclosure of the enemy's superiority.

There are also problems of a fundamental nature that are not of immediate interest to the fighting services and of no interest at all to production men. Such long-range research is most difficult to handle in war time, because of the overwhelming pressure for immediate results. Short-range problems are also more readily solved, and research men are human enough to pitch in with greater enthusiasm where tangible results are in sight.

However, research that discloses new knowledge and clarifies obscure physical phenomena may lead to revolutionary changes in the art, and to inventions of the highest importance. Fundamental discoveries are unpredicatable both as to their nature and as to the time of their appearance, but we cannot afford to give the enemy a clear field. Total war employs all aspects of scientific research.

It is not so long ago that fundamental studies of the combustion process in an engine cylinder resulted in a better concept of the phenomenon known as knocking or detonation, and to Thomas Midgely's invention of tetra ethyl lead to control it. Further research now enables the oil industry to supply superior fuel of high anti knock quality, to operate in modern high compression engines.

Research on the aerodynamics of flow separation resulted in a design for cowling airplane engines that cut the drag 75 per cent and made commercial air transport and modern long-range bombers practical. More recent aerodynamic research has resulted in wing and propeller forms that permit much higher speeds.

During the last war, fundamental research was largely interrupted in favor of immediate problems, with the notable exception of a small group at Göttingen University in Germany. Their research could hardly have appealed either to the military mind or to industrial leaders. It dealt with the mathematical theory of potential flow in an idealized frictionless medium and with the nature of vortex motion. It was an academic effort to explain how and why an airplane wing achieves its lift. From these studies, about which we learned only after the war, came applications of great practical importance. Although German airplanes did not win that war, they frequently forced the pace.

An example of a radical change in the art resulting from a fundamental discovery is to be found in the hardened aluminum alloy, named duralumin. Our first knowledge that the enemy possessed a superior light metal came during the war in 1916 from examination of a wrecked Zeppelin. By 1918 German airplanes were made of this metal. Now it is practically the universal standard, and a vast aluminum production is a military necessity.

In Norway the interruption of weather reports from the North Atlantic

(*Continued on page 38*)

* Reprinted from the *Journal of the Franklin Institute*, Vol. 234, No. 2, August, 1942. Read at the Medal Day Meeting, Wednesday, April 15, 1942.

† Chairman, N.A.C.A.; Head of Department of Mechanical Engineering and Department of Aeronautical Engineering, Massachusetts Institute of Technology.

FASTEST, FIGHTIN'EST PLANE "the Havoc"

The Douglas A-20 "Havoc" has been termed the most vicious, versatile airplane of the war. Also known in Britain as the "Boston," it is used as an attack bomber, torpedo bomber, night fighter, long range fighter, pursuit, interceptor, intruder. For three years the "Havoc" has been the scourge of the Axis on every front. And no enemy craft has yet matched it! So, America, your aircraft industry has out-designed and is now out-producing our enemies. Yankee ingenuity will win! Douglas Aircraft Company, Inc., Santa Monica, Calif.

DOUGLAS

Member, Aircraft War Production Council, Inc.

DOUGLAS BUILDS...BOMBER-FIGHTERS: THE A-20 "HAVOC" AND "BOSTON" • A-24 "BANSHEE" • SBD "DAUNTLESS" • TBD "DEVASTATOR"
WAR TRANSPORTS: THE DC-3 AND C-47 "SKYTRAIN" • C-53 "SKYTROOPER" • C-54 "SKYMASTER"

The Automatic Radio Compass

WILBUR L. WEBB* AND GERALD O. ESSEX†

Bendix Aviation Corporation

Introduction

The automatic radio compass is one of the latest developments in radio navigation devices. It is the present result of many years of development on various radio direction finders. A brief description of radio compasses will be given from the standpoint of operation in modern aircraft.

The automatic radio compass is not limited to use in aircraft and could be used equally well on land or sea. A simple comparison of the relative speeds of aircraft and water craft indicates that the pilot of an aircraft has considerably less time to obtain radio bearings than the pilot of a comparatively stationary ship. This is probably the main reason for the development of the automatic radio compass to its present state and for its application to aerial navigation.

The terms "radio compass" and "radio direction finders" have been used synonymously and both have the same general meaning. In some cases the term "radio compass" has been employed to designate radio equipment used for obtaining radio bearings and having a visual indicator, as compared to the use of the term "radio direction finders" for equipment having only an aural indication. The use of these terms in the above manner has no true meaning and has not been consistent. Automatic radio direction finders are being termed as both direction finders and compasses in the field at present. In this discussion, the term "radio compass" will be used to designate a radio direction finder. Thus, the term "automatic radio compass" could be applied to radio equipment functioning so that an indicator automatically points to a radio transmitting antenna, similar to the action of the needle of a magnetic compass with respect to the North magnetic pole.

Types of Radio Bearing Equipment

The Directional Loop Antenna

Three types of radio equipment are in general use for obtaining radio bearings. The original type consists of a directional loop antenna connected to the input of a properly designed receiver. The first step in obtaining a radio bearing with this equipment is to adjust properly the gain of the receiver and to rotate manually the loop antenna until a "null" or minimum signal position of the loop is found, using the output of a headset as an aural indication. Since a loop antenna has a "figure-eight" pattern with two null positions displaced by 180 deg. the radio bearing thus obtained from a calibrated azimuth scale attached to the shaft of the loop antenna indicates the line of direction only. That is, the radio transmitter may be either directly ahead or directly behind the observer. The second step consists of eliminating this 180-deg. ambiguity and is known as obtaining the "sense" of the radio bearing. This is usually accomplished by manual operation of a switch that combines the signal voltage obtained from a small nondirectional or "sense" antenna with that from the directional loop antenna. The loop is then rotated a predetermined number of degrees from the azimuth scale reading noted above, which causes an increase or decrease in headset output, depending upon the direction of the received radio signal. Such equipment is suitable for shipboard use by a well-trained operator who has plenty of time to obtain radio bearings. It is not generally suitable for aircraft use by a pilot when radio bearings must be rapidly obtained in order to establish the location or position "fix" of the aircraft. The equipment may be used for "homing" or flying directly toward a radio transmitter. This is inconvenient for the pilot, since he must continuously monitor the received signal and orient the aircraft so that a minimum output is obtained from the headset.

The Visual Right-Left Indicator Radio Compass

The next improvement in aircraft radio equipment for aerial navigation was the visual right-left indicator type of radio compass. This type of radio compass combines the output voltages from a directional loop antenna and a nondirectional sense antenna similar to the method employed in the aural null equipment, but the switching operation in this case is performed continuously and at a predetermined rate by suitable electrical circuits contained within the radio compass unit. A zero-center type meter is connected to the radio compass output so that the operator may obtain a visual indication. A radio bearing is obtained with this equipment by manually rotating the loop antenna until the pointer of the meter assumes the zero or "on-course" position. The radio bearing is then read from an azimuth scale mechanically attached to the shaft of the loop antenna. The 180-deg. ambiguity in direction is eliminated by following a definite procedure in rotating the loop antenna to bring the indicator to the on-course position.

The right-left radio compass is a marked improvement over the original aural "null"-type equipment in that a visual bearing indication is obtained in a shorter time. In addition, the right-left type radio compass is designed so that a minimum headset output does not result while a radio bearing is being taken. This means that the pilot may receive intelligence from the radio station while in the process of obtaining a radio bearing. Probably the most popular use of the right-left type of radio compass is as a visual homing indicator while flying directly toward a given radio station. The loop is rotated and set so that an on-course indicator reading is obtained when the radio station is directly ahead of the aircraft. A deviation of the aircraft from the on-course direction is shown by movement of the indicator needle to either side of the zero position. Thus, if the aircraft is turned to the left from an on-course heading, the indicator needle moves to the right of the zero position, indicating that the aircraft must be turned to the right to regain the on-course heading.

Automatic Radio Compass

The automatic radio compass is a refined modification of the previous right-left types. Automatic rotation of the loop antenna is provided so that it is unnecessary for the pilot to rotate manually the loop antenna to obtain a radio bearing. The loop automatically seeks the correct position and thus gives the pilot an immediate bearing indication on a remote azimuth indicator. (The indicator is shown in Fig. 1.) No adjustments other than tuning in the proper radio signal need

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* Chief Engineer, Bendix Radio Division.

† Project Engineer, Bendix Radio Division.

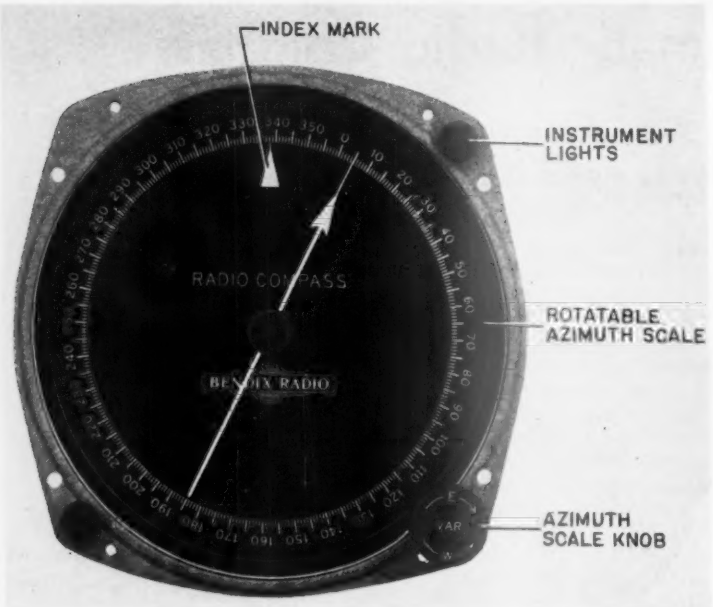

FIG. 1. Bearing indicator.

be made by the pilot to obtain a radio bearing relative to the axis of the aircraft when an automatic radio compass is used. This effects a considerable saving in time in establishing a position "fix" by radio bearings.

The automatic radio compass has a marked advantage over other types during the presence of "night effect" or swinging bearings, since the direction of the radio signal is continuously indicated. Under certain conditions the received radio signal appears to shift in direction as though the radio station were wandering from side to side. This is sometimes termed as night effect but is commonly called a swinging bearing; it is particularly noticeable when flying over mountainous terrain as well as during the hours near sunset and sunrise. The phenomenon is caused by reflections of the radio wave at some point along its path between the transmitter and receiver. The automatic radio compass immediately warns the pilot of the presence of such conditions by the swinging action of the bearing indicator pointer. A radio bearing obtained with a manual radio compass during these conditions could be seriously in error, since the pilot may "catch" the bearing near its maximum deviation.

General Operation of the Automatic Radio Compass

The automatic radio compass is a null seeking device. It is arranged so that a control circuit will deliver power to an electric motor when the loop antenna is in any position other than the correct zero signal or null position. The shaft of the motor is geared to the shaft of the loop so that application of power to the motor causes the loop to rotate toward the null. The control circuit ceases to supply power to the motor when the loop reaches its null position. If the position of the loop antenna is changed to either side of its null, or if the direction of arrival of the radio signal is changed, the control circuit immediately returns the loop to the null position. The angular position of the loop is transmitted to a remote bearing indicator by an electrical indicating system. The azimuth scale of the bearing indicator is calibrated in degrees so that the radio bearing corresponding to the null position of the loop will be indicated directly by the pointer. Ambiguities of 180 deg. in direction are eliminated by making the control circuits stable on only one of the two null positions of the loop antenna.

Compass Components

The various components employed in an automatic radio compass installation are shown in the simplified block diagram (Fig. 2.). The present design consists of five items: the automatic loop unit, the radio compass unit, the loop director unit, the bearing indicator, and the remote control unit. A detailed description of the complete operation of this equipment is beyond the scope of this paper, but an explanation of the general operation as an automatic compass will be given.

Induced Loop Voltages

The voltage induced in a vertical nondirectional antenna is in phase with the flux of the passing radio wave and is equal for all azimuth angles. The voltage induced in a directional loop antenna reaches a maximum when the plane of the loop is in line with the direction of arrival of the radio wave from the transmitter and is zero when the plane of the loop is at right angles to the direction of arrival. Hence, there will be two positions of the loop for maximum and zero-induced voltages. These zero voltage positions are referred to as the null positions of the loop. The voltage induced in the loop is 90 deg. out of phase with the flux of the radio wave and is therefore 90 deg. out of phase with the voltage induced in the vertical antenna. The loop voltage changes phase abruptly by 180 deg. as the loop is rotated

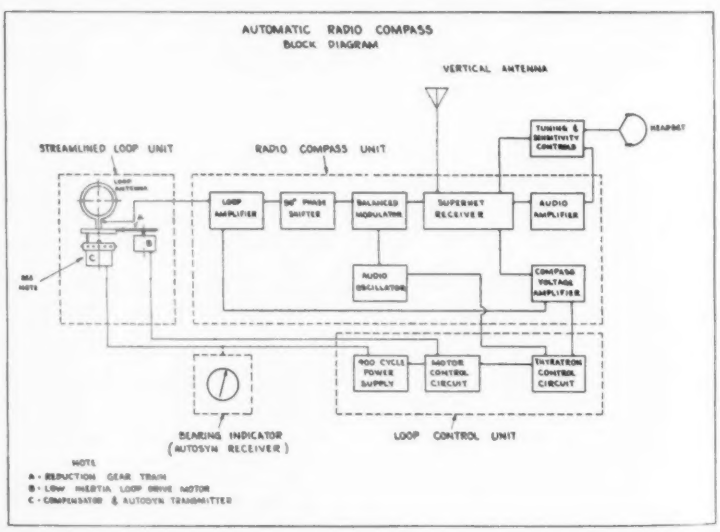

FIG. 2. Block diagram.

through a null position. This is an inherent characteristic of a loop antenna that is used to advantage in an automatic radio compass.

Coupling Circuit

A resonant coupling circuit connects the output voltage from the loop antenna to an amplifier tube in the radio compass. The amplified loop voltage is shifted so that it is either in phase or 180 deg. out of phase with the antenna voltage, depending upon which side of the loop is closer to the transmitter.

The phase-shifted voltage is then impressed in phase upon the grids of a pair of modulator tubes. The grids of the modulator tubes are controlled in phase opposition by an audio oscillator, so that only one modulator tube will amplify the phase-shifted loop signal at a given instant. The plates of the modulator tube are coupled in phase opposition to the input circuit of the superheterodyne receiver by a center-tapped coil. The vertical nondirectional antenna is also coupled to the input circuit of the receiver. Since the modulator plates are coupled in phase opposition to the receiver input circuit and since only one of the modulator tubes operates during each half cycle of the audio-oscillator frequency, it is evident that the output voltage from the modulator plate circuit will alternately add to and subtract from the voltage contributed by the vertical antenna to the input circuit of the receiver. The combined signal input to the receiver therefore consists of a radio frequency signal whose amplitude is varied or modulated at the audio-oscillator frequency. The percentage modulation of the radio frequency signal is proportional to the displacement of the loop from its null position, and the percentage modulation for the null position of the loop is zero.

Compass Output Voltage

The modulated radio frequency signal is amplified by appropriate radio frequency amplifiers in the receiver and finally demodulated so that the radio frequency components are eliminated. The modulated signal appears at the output of the receiver as an audio voltage, which will be called the compass output voltage to distinguish it from other audio outputs such as speech or music. It has been mentioned that the output voltage from the loop antenna changes phase abruptly by 180 deg. as the loop passes through a null position. This causes the demodulated audio output from the receiver to also shift in phase by 180 deg. The amplitude of the compass output voltage depends upon the percentage modulation of the radio frequency signal and therefore depends upon the position of the loop. Thus, the compass output consists of a voltage having a frequency equal to that of the audio oscillator with either a 0- or 180-deg. phase relation and variable in amplitude.

The compass output voltage is compared to the audio-oscillator voltage for control purposes in the following manner. The compass output voltage is amplified and fed through a band-pass filter to the grids of two thyratron control tubes in phase opposition. Plate voltage for the thyratrons is obtained from a plate control tube connected in series with the high-voltage supply lead. The audio-oscillator voltage is coupled to the grid of the control tube so that plate voltage is supplied to both thyratrons during one-half of the audio-oscillator cycle and cut off during the next half cycle. If the grid of the first thyratron is increased in a positive direction above a critical point by the compass output voltage during the half cycle when the thyratron plate voltage is "on," the first thyratron will ignite and allow plate current to flow until the plate supply voltage is removed. The second thyratron will not ignite during this half cycle since its grid voltage is increased in a negative direction. The thyratrons cannot operate during the time when the plate supply voltage is cut off by the action of the plate control tube. The circuits are arranged so that the compass output voltage obtained when the radio signal arrives from one side of the loop null causes only one thyratron to operate. The other thyratron operates when the radio signal arrives from the opposite side of the loop null. No compass output voltage is obtained when the loop is on the null and both thyratrons remain extinguished. A method of converting the relationship between the compass output voltage and the audio-oscillator voltage into bidirectional motor rotation is therefore available if the motor control circuit is inserted in the plate circuits of the thyratrons.

Thyratron Tube Control

The selective operation of the thyratron tubes is used to control a normally balanced bridge circuit having one winding of the two-phase 400-cycle loop drive motor as the element common to both sides of the bridge, as shown in Fig. 3. Saturable reactors are inserted in the plate circuits of the two thyratron tubes and are used as the variable arms of the bridge circuit. Power is supplied to the bridge circuit from a 400-cycle rotary inverter by a center-tapped transformer, and the second winding of the low inertia motor is continuously excited with a fixed amount of 400-cycle current from the primary of the transformer. If both thyratrons are extinguished, no direct current will flow through the primary of the saturable reactors and the impedance of the secondaries of the two reactors will be equal and comparatively high. The bridge circuit will therefore be balanced, and no current will flow through the winding of the 400-cycle low inertia motor connected in the bridge circuit. Should the first thyratron draw plate current, the core of the associated reactor will be saturated by the increase in magnetic flux and the impedance of the secondary coils will be reduced to a low value, as compared to the impedance of the secondary of the other reactor. This unbalances the bridge circuit and permits 400-cycle current to flow through the motor winding in a given phase relation. The amount of current flowing in the motor winding depends upon the degree of unbalance of the bridge circuit, which in turn depends upon the amount of thyratron plate current flowing through the primary winding of the saturable reactor. If the first thyratron is extinguished and the second thyratron ignites so that plate current flows through the primary winding of its associated reactor, the core of that reactor will be saturated with the result that 400-cycle current will flow through the low inertia motor winding in the opposite phase relation. The direction of rotation of a two-phase motor may be changed by reversing the phase of the current flowing in one of the two field windings. Hence, the operation of a given thyratron rotates the motor shaft in one direction while the operation of the other thyratron rotates the motor shaft in the opposite direction. The thyratrons and saturable reactors may be termed as electronic switches which operate to connect one winding of the two-phase motor to either side of the center-tapped secondary of the power transformer. Maximum torque is obtained from the shaft of a two-phase motor when the currents in the two field windings have a 90-deg. phase relationship. The proper phase relations are obtained by a capacitor in series with the continuously excited winding.

The various circuits in the automatic radio compass are phased and connected so that the control circuit always returns the loop to only one of its two null positions. Thus, the control circuits operate the loop drive motor to choose the shortest angular path toward the proper null when a radio signal is tuned in on the radio compass unit, since the shaft of the motor is geared to the loop shaft. The loop must be a definite amount off its null in order for the thyratrons to draw plate current, since the thyratron tubes are biased so that they normally cannot draw plate current. The bias may be ad-

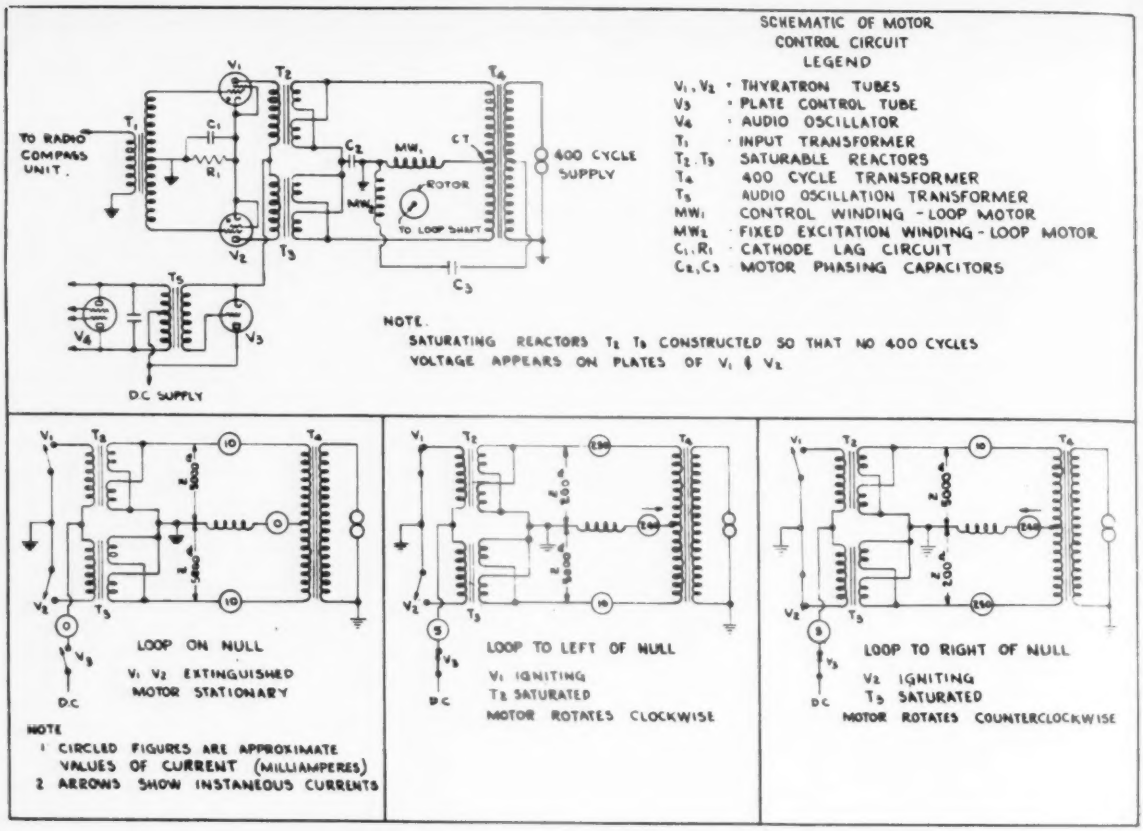
SCHEMATIC OF MOTOR CONTROL CIRCUIT
LEGEND
V1, V2 - THYRATRON TUBES
V3 - PLATE CONTROL TUBE
V4 - AUDIO OSCILLATOR
T1 - INPUT TRANSFORMER
T2, T3 - SATURABLE REACTORS
T4 - 400 CYCLE TRANSFORMER
T5 - AUDIO OSCILLATION TRANSFORMER
MW1 - CONTROL WINDING - LOOP MOTOR
MW2 - FIXED EXCITATION WINDING - LOOP MOTOR
C1, R1 - CATHODE LAG CIRCUIT
C2, C3 - MOTOR PHASING CAPACITORS
TO RADIO COMPASS UNIT.
400 CYCLE SUPPLY
ROTOR
TO LOOP SHAFT
D.C. SUPPLY
NOTE.
SATURATING REACTORS T2 T3 CONSTRUCTED SO THAT NO 400 CYCLES VOLTAGE APPEARS ON PLATES OF V1 & V2
LOOP ON NULL
V1 V2 EXTINGUISHED
MOTOR STATIONARY
LOOP TO LEFT OF NULL
V1 IGNITING
T2 SATURATED
MOTOR ROTATES CLOCKWISE
LOOP TO RIGHT OF NULL
V2 IGNITING
T3 SATURATED
MOTOR ROTATES COUNTERCLOCKWISE
NOTE
1 CIRCLED FIGURES ARE APPROXIMATE VALUES OF CURRENT (MILLIAMPERES)
2 ARROWS SHOW INSTANEOUS CURRENTS

FIG. 3. Schematic of motor control circuit.

justed so that the action of the thyratrons will be controlled to obtain the required orienting sensitivity. Adjustment may be made so that the loop will hunt its null by any desired amount within ±0.2 to ±1 deg., or the thyratron sensitivity may be reduced to a point where there will be no hunting.

INERTIA COMPENSATION

Although the loop motor has extremely low inertia and can be stopped almost immediately after removal of the power, the inertia of the gear train and loop causes the loop to overshoot its null. This tendency to overshoot is reduced by means of a time-lag circuit in the bias circuit of the thyratrons and by direct current damping of the low inertia motor. When a thyratron is passing plate current, the cathode bias is built up to its maximum value across a large capacitor in the cathode circuit of the thyratrons. As the loop approaches its null, the excitation voltage on the grid of the thyratron is reduced faster than the cathode bias so that plate current ceases to flow an appreciable time before the loop reaches its null. The cathode bias returns to normal a fraction of a second after the loop arrives at the null, since the capacitor discharges through the cathode bias resistor.

THE AZIMUTH INDICATING SYSTEM

It is now evident that it is only necessary to know the position of the loop with respect to the plane's heading, since the loop is automatically held on its null position for any given signal to which the radio compass is tuned. The azimuth indicating system employed in the automatic radio compass utilizes the two self-synchronous or autosyn motors contained in the bearing indicator and automatic loop unit. These motors resemble miniature three-phase motors in some respects, having a three-phase field winding and a double-pole rotor. If two similar autosyn units are properly connected and their windings excited from a suitable supply, the rotor of one unit assumes an angular position identical to that of the other rotor. If the shaft of the first autosyn (or transmitter) is angularly displaced, the shaft of the second autosyn (or receiver) immediately seeks a similar position. The azimuth position of the loop antenna may thus be indicated in the cockpit of the aircraft or at some other location remote from the loop antenna, since the autosyn transmitter is coupled to the shaft of the loop. One or more autosyn receivers may be operated from a single autosyn transmitter so that the pilot and navigator may have separate bearing indicators connected to the same loop. The compensator and the reason for its use to couple the loop shaft to the autosyn transmitter have not been described and may be of interest.

RADIO FIELD DISTORTION

Distortion of the radio field in the vicinity of the aircraft is always present and is caused, in general, by the structure of the aircraft. This means that the null position of the loop antenna mounted on the aircraft may not always coincide with the true direction of arrival of the radio signals. Such an error is known as quadrantal error and is sometimes referred to as aircraft error. Since distortion of the radio field caused by the aircraft alone is fairly symmetric with respect to the axis of the aircraft and practically uniform over a given frequency tuning range, the relative quadrantal error for a particular radio compass installation may be determined by a definite calibration procedure. The correction to be applied to radio bearings obtained from various azimuth direc-

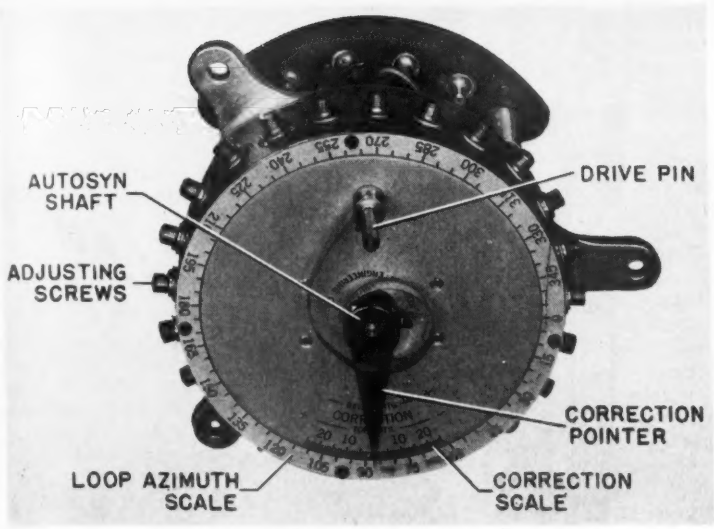

FIG. 4. Loop compensator unit.

tions with respect to the centerline of the aircraft may be kept in tabular or graphic form if an automatic compensator or corrector is not provided. The compensator used in the automatic radio compass serves to apply a correction to the position of the rotor of the autosyn transmitter and thus to compensate for the quadrantal error introduced by the aircraft structure for a given loop position. The compensator unit is shown in Fig. 4.

THE COMPENSATOR

The compensator consists of a circular steel tape supported at 15-deg. intervals by adjustment screws so that the tape can be moved in a radial direction. A roller rides on the inner surface of the tape and is mounted on a rack that engages a pinion on the shaft of the autosyn transmitter. The rack and roller are carried on a circular plate that floats on the shaft of the autosyn. The plate is coupled to the shaft of the loop so that the plate and roller rotate with the loop. If the tape forms a circle concentric with the autosyn shaft, the roller travels at a constant radius as the loop is rotated, and the angular position of the autosyn rotor is not changed with respect to the loop, since there is no motion between the rack and pinion. When the form of the tape is changed to an ellipse by moving the adjustment screws in a radial direction, the radius of the roller path varies as the loop is turned, and relative motion is obtained between the rack and pinion. This causes the angular position of the autosyn rotor either to be advanced or retarded with respect to the position of the loop. The angular difference between the position of the autosyn rotor and the loop is indicated by the reading of the pointer on the correction scale. The null position of the loop corresponds to the position of the correction scale zero mark on the outer azimuth scale.

The adjustment screws are first adjusted for zero correction at all azimuth points. After a quadrantal correction curve is obtained, the compensator is removed from the loop unit and proper corrections are applied at every 15-deg. point. Inasmuch as the autosyn in the loop is corrected for the distortion produced by the aircraft structure and since the autosyn in the bearing indicator is electrically coupled to the autosyn in the loop, the pointer on the bearing indicator will indicate the true direction of arrival of the radio signal.

GROUND CALIBRATION

There are two general methods used for determining quadrantal or aircraft error—namely, a calibration made on the ground or a calibration obtained in the air under actual flight conditions.

Ground calibration of an installation will usually agree fairly well with data obtained from a flight calibration of the same installation, provided the aircraft is supported in flying position during the calibration procedure. The procedure generally used for ground calibration is to orient the aircraft so that the fore-and-aft axis coincides with a radial line extended from a given radio station and to note the reading of the bearing indicator for the zero heading. The aircraft is oriented to a new position so that its axis makes a known angle with the line from the radio station, and the new reading of the bearing indicator is noted. This procedure is repeated step by step until the aircraft has been turned through a complete 360 deg. Calibration at increments of 15 deg. will usually furnish sufficient data for an accurate quadrantal error curve. Accurate orientation is obtained by the use of an engineer's transit or a pelorus mounted on the aircraft. In cases where the radio transmitter cannot be seen, the bearing from the test location to the radio station must be determined from sufficiently accurate maps or charts prior to the calibration. Orientation of the aircraft is then based on a reference line of sight from the aircraft to a distant object such as a tall building. When a portable transmitter is available and when it is not convenient to turn the aircraft on the ground and still maintain its flying position, this method is modified slightly by moving the portable transmitter around the stationary aircraft in known angular increments.

Particular care must be taken in ground calibrations to be certain that the direction of arrival of the radio signal is not being shifted or altered by the presence of surrounding objects such as power lines or metallic structures.

Flight Calibration

Flight calibration of the radio compass is similar to ground calibration because readings of the radio bearing indicator are obtained for various headings of the aircraft with respect to a known radio station. The first step in a flight calibration is to head the aircraft directly toward a radio station and check the angular difference between the indicated radio bearing and the zero heading of the aircraft. Accurate orientation of the aircraft for the zero heading check may be obtained by sighting directly on the radio station antenna or by flying the aircraft directly over and along a ground reference line that will pass directly through the radio transmitter when extended. The complete flight procedure should be made only in the absence of cross winds and rough air, since appreciable errors in orientation of the aircraft may be introduced by these factors. After checking the radio bearing for the zero heading of the aircraft, bearing indicator readings are obtained for 15-deg. intervals in headings of the aircraft with respect to the radio station through the complete 360 deg. of azimuth.

METHODS OF CALIBRATION

Three methods of calibrating a radio compass in flight after the zero heading has been checked will be described.

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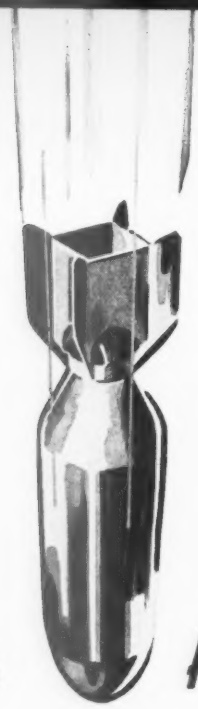

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Figure-of-Eight Method

One accurate and satisfactory method of flight calibration is that of flying the aircraft on a series of given headings over a ground check point. This method will be referred to as the figure-of-eight method. A ground check point such as a small town or road intersection having a known position relative to the radio station is selected. The reading of the bearing indicator is noted when the aircraft is heading exactly toward the radio station and is directly over the ground check point. The aircraft is then flown beyond the ground check point far enough so that a right or left turn may be executed and a new directional gyro heading established before the ground check point is reached on the return path. The reading of the bearing indicator is again noted when the aircraft is directly over the ground check point. This procedure is repeated until radio bearings have been obtained directly over the ground point for every 15-deg. change in gyro heading of the aircraft. The flight path followed in this method would appear to be a series of overlapping figure-of-eight turns having a common crossover point. This method has no location errors since all radio bearings are taken over a fixed point.

Ground Reference Line

The figure-of-eight method may be modified to a shorter procedure if a suitable reference line on the ground can be located. A section line, highway, railroad, or power line heading directly toward the radio station is used as the reference line. The aircraft is flown toward the radio station and directly over the reference line to obtain the radio bearing corresponding to the zero heading of the aircraft. The directional gyro is set to zero when the heading of the aircraft coincides with the reference line. A slight left turn is then executed, and the aircraft is flown far enough from the reference line so that a partial right turn may be made in order to establish a steady 15-deg. gyro heading before the reference line is crossed. The reading of the bearing indicator is noted when the aircraft is crossing the reference line. After crossing the reference line, flight is continued on the same heading until the aircraft is a small distance to the right of the reference line. A partial left turn is then made, and a steady 345-deg. gyro heading is established before the reference line is recrossed. The reading of the bearing indicator is noted for this heading when the aircraft is again crossing the line. Two more radio bearings are obtained in a similar manner for gyro headings of 30 and 330 deg., respectively. After flight of the aircraft is continued on the last gyro heading far enough beyond the reference line, a right turn is executed and finished so that the aircraft is directly over the reference line but headed directly away from the radio station. This provides a method of checking the directional gyro, since the gyro should now read 180 deg. The gyro is then reset to 180 deg. if necessary, and the radio bearing for this heading is noted while the aircraft is directly over the ground line. The above flight plan is then continued until radio bearings have been obtained for every 15-deg. difference in heading of the aircraft. The path followed by the aircraft in this method would appear as a series of zigzag courses to and from the radio transmitter. Accurate flight calibration of a radio compass may be obtained with this method since the gyro compass may be easily checked at regular intervals. Compared to the figure-of-eight method given above, the ground reference line method provides for complete calibration of the radio compass in a shorter time, but both methods can be accomplished with the same degree of accuracy.

It would appear upon first thought that the simplest and quickest method of flight calibration would be to fly the aircraft in a circular path and note the radio bearings corresponding to given headings of the aircraft with respect to a radio station located outside the circular flight path. This would be satisfactory if the diameter of the flight circle could be held small enough with respect to the distance from the center of the flight circle to the radio station to prevent the introduction of appreciable errors. This method is not practical because a circle in the order of 7 miles in diameter is required if radio bearings are obtained for 15-deg. increments in aircraft heading. Errors as great as 7 deg. would be introduced in some of the radio bearings for a distance of approximately 60 miles from the transmitter.

Two-Circle Method

A third method of flight calibration that may be used in the absence of a suitable ground line and when the calibration must be accomplished in the shortest possible flight time is a refinement of the single-circle method. The azimuth reading of the radio bearing indicator corresponding to the zero heading of the aircraft is determined as accurately as possible by ground checks and by flight checks with the aircraft headed accurately toward a visible radio transmitting antenna. A suitable ground check point is then selected, located at least 50 miles from the radio station to be used for the flight calibration. The aircraft is flown along the extension of the line from the radio station to the ground check point, approaching the check point from the side opposite the station. Correct orientation of the aircraft is indicated by the previously determined bearing indicator reading for the zero heading check. The directional gyro is set to zero for an aircraft heading of zero with respect to the radio station. When the aircraft is directly over the ground check point, a slight left turn is executed so that a steady gyro heading of 345 deg. is established, and the azimuth reading of the bearing indicator is noted. A second left turn is executed to establish a steady gyro heading of 330 deg., and the azimuth reading of the bearing indicator is noted for this heading of the aircraft. This procedure is continued until a radio bearing has been obtained for each 15-deg. change in heading of the aircraft. If equal times between consecutive headings are allowed, the finish of the 15-deg. gyro heading will bring the aircraft directly over the ground check point. The directional gyro is then checked by establishing the original zero heading over the ground point as shown by the bearing indicator. Any reasonable difference from the original zero reading of the directional gyro is noted so that the headings established during the complete left turn may be proportionately corrected.

After the original zero heading is established and the gyro reset to zero if necessary, a slight right turn is made so that a steady gyro heading of 15 deg. is established and the bearing indicator reading is noted for this heading. Following the procedure used in the completed 360-deg. left turn, radio bearings are obtained for each 15-deg. change in gyro heading of the aircraft during a complete 360-deg. right turn. The average time between consecutive headings is held as nearly equal as possible so that the complete 360-deg. right turn will be the image of the completed left turn. The finish of the 345-deg. gyro heading in the right turn will bring the aircraft directly over the ground check point. The zero heading of the aircraft is re-established by the radio bearing indicator, and the zero of the directional gyro is rechecked. Again, any reasonable difference in gyro readings is noted for proportional correction of gyro headings established in the complete right turn. The data obtained during the two opposite turns furnishes two radio bearings for each 15-deg. change in gyro heading of the aircraft. The average of the two radio bearings for each gyro heading is used to determine the quadrantal error.

Since the two circles are approximately equal in diameter and tangent to the line between the radio station and the ground check point, the average of the two radio bearings for a

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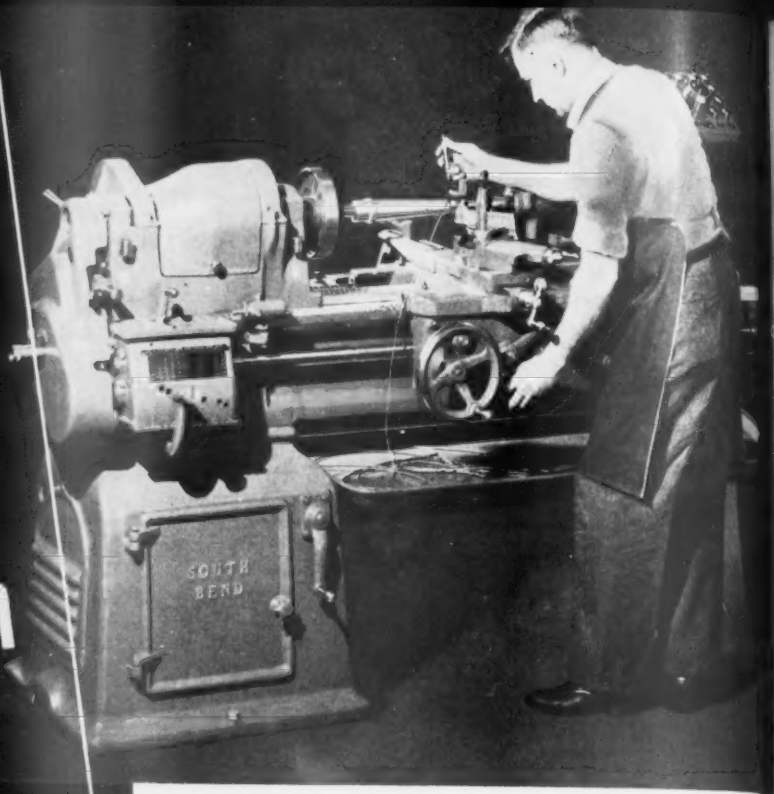

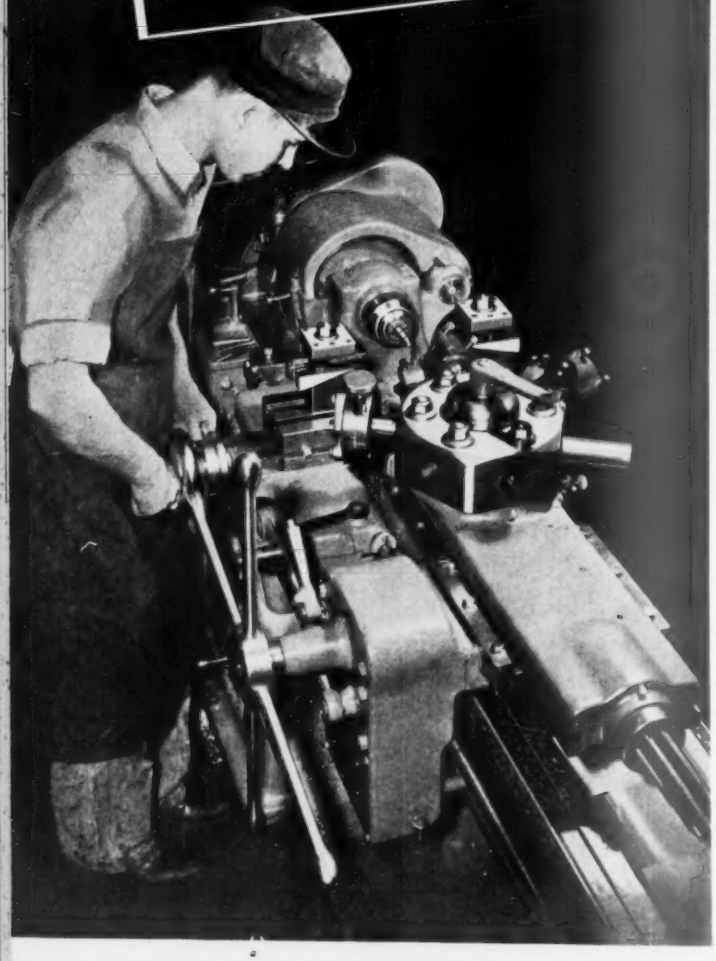

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given gyro heading practically eliminates the displacement errors of the single circle method mentioned. For example, assume that two opposite circles having diameters of approximately 7 miles are flown to start and finish over a given ground point located approximately 60 miles from the station. The azimuth position of the radio station with respect to the axis of the aircraft for the 180-deg. gyro course in the left turn would be approximately 187 deg. Similarly, the azimuth position of the radio station with respect to the aircraft for the 180-deg. gyro course in the right turn would be approximately 173 deg. The average of the two azimuth positions is 180 deg.

There is a small error introduced in this method for some courses because of the fact that a given gyro course is closer to the radio station in one turn and farther away from the station in the opposite turn. For instance, the 90-deg. gyro course in the left turn, for the above example, would be approximately 7 miles closer to the radio station than the 90-deg. gyro course for the right turn. However, the distance of each course from the line joining the radio station to the ground check point would be approximately equal in both cases. For a 90-deg. heading the angle between the reference line in the left turn and a line to the aircraft from the station would be slightly larger than the angle between the reference line and the line to the aircraft in the right turn. The error introduced would be half of the difference of these two angles. The maximum error introduced in a flight plan having the dimensions given in the above example would be less than 1 deg. and would occur between the 90- and 180-deg. and 180- to 270-deg. gyro courses. For a given circle diameter, the introduced error decreases with an increase in distance from the radio station to the ground check point. The two-circle method results in a considerable saving in flight time, since each circle may be completed in approximately 10 min. if a time of 25 sec. is allowed for each 15-deg. change in heading, but this method is not so accurate as the two previous methods.

Flight calibrations must be made in the absence of cross winds and rough air if accurate results are to be obtained. Appreciable error would be introduced into a flight calibration by the effects of a moderate cross wind unless the heading of the aircraft could be determined by the use of a drift sight. It is almost impossible to obtain accurate readings of the radio bearing indicator or gyro compass when the flying attitude of the aircraft is being continuously and suddenly changed in "rough air."

Determining Quadrantal Error

The quadrantal error of a given aircraft installation is determined from the calibration data in the following manner. The correct or true radio bearing may be obtained from the noted headings of the aircraft, keeping in mind that the azimuth readings of the radio bearing indicator are opposite in direction from the readings of the directional gyro. The difference between the true radio bearing and the observed radio bearing as read from the bearing indicator for a given gyro heading is the correction to be applied to the bearing indicator for that heading. Thus, a gyro heading of 315 deg. (referred to zero when the aircraft is headed directly toward the radio transmitter) corresponds to a true radio bearing of 45 deg. The observed radio bearing for this gyro heading may be 30 deg. The correction to be applied to the indicator reading is plus 15 deg. to make the observed radio bearing agree with the true radio bearing.

Since adjustment screws are provided at regular 15-deg. intervals on the compensator unit and since observed radio bearings are obtained at random intervals from the calibration data, the compensator corrections are obtained from a plotted curve. A typical correction curve resembles two cycles of a sine wave having positive corrections for indicator readings from 0 to approximately 90 deg. and from 180 to approximately 270 deg. The differences between the true radio bearings and the observed radio bearings for 15-deg. increments in gyro headings are plotted in the ordinate direction as corrections against the observed radio bearings as abscissa. A smooth curve is drawn through the plotted points. The ordinate readings of the curve at 15-deg. intervals along the observed bearing scale are applied to the corresponding adjustment screws on the compensator. The position of the bearing indicator needle is thus advanced or retarded with respect to the position of the loop to indicate the true direction of arrival of the radio signal.

Aerial Navigation

The calibrated automatic radio compass may be used for aerial navigation by determining the position of the aircraft with respect to ground points and also may be used for homing procedure toward a radio station.

To fly toward a given transmitter or "home" it is only necessary for the pilot to tune in the known radio station in the usual manner. He then visualizes the pointer of the indicator as always pointing to the radio station, while the zero index on the indicator scale represents the heading of the aircraft. If the pointer is to the right of the zero mark by 10 deg., the pilot is immediately informed that the plane is headed 10 deg. to the left of the desired course, since the pointer indicates the direction of the radio station. The heading of the aircraft must then be changed until the pointer coincides with the zero index on the azimuth scale. Flight is then continued with the pointer kept on the zero index until the aircraft arrives directly over the radio station. As the aircraft passes over the radio station, the pointer will rotate through 180 deg. and thus inform the pilot that the radio station has been passed. This indication is positive and occurs in several seconds.

Cross-Wind Effects

The path followed by an aircraft homing toward a given radio station will be curved instead of straight if cross winds are present. The automatic compass has an advantage over other types for homing flights in that the angular deviation of the heading of the aircraft from the direction of the radio station is shown on the indicator scale. This enables the pilot to "home" on a straight line toward the radio station by adjusting the heading of the aircraft or "crabbing" by an angle necessary to compensate for the effect of the cross wind when the direction and magnitude of it is known. Conversely, the effect of an unknown cross wind may be observed from the change in radio bearing with respect to a constant gyro heading of the aircraft during a short time. The usual practice in homing during an unknown cross wind is to establish an aircraft heading by continuous trial until the difference between the gyro heading and the radio heading remains constant.

Radio Bearings

Aerial navigation of the aircraft by the use of a radio beam and the automatic radio compass is convenient in many cases. A pilot flying along a given radio beam may tune the automatic radio compass to a radio station situated to the right or left of the beam path, having previously determined what azimuth reading of the bearing indicator should be obtained when the aircraft is over a definite point along the path of the beam. Occasional glances at the changing position of the pointer indicate to the pilot that the desired point is being approached. When the pointer indicates the predetermined radio bearing, the aircraft is over the required location. Similarly, the position of the aircraft along the path of the radio beam may be spotted at any time by plotting the intersection of the radio beam with a radio bearing from a known radio station situated to the right or left of the beam.

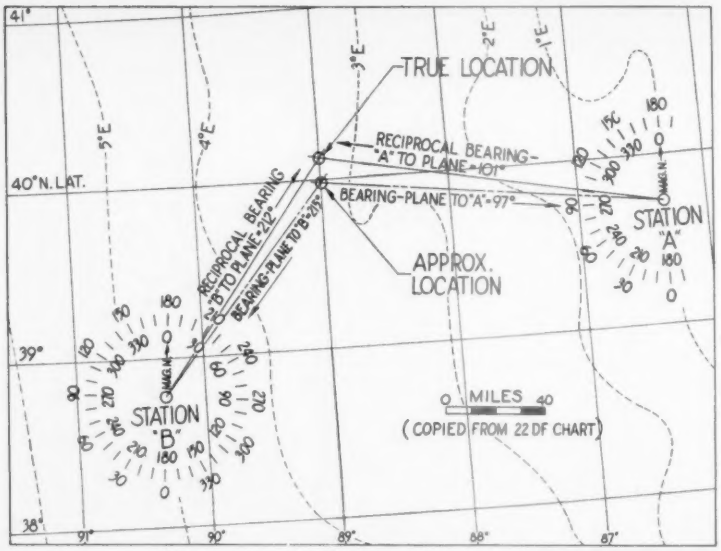

FIG. 5. Example of location by radio bearings.

The location of the aircraft at a given time may be determined by plotting the radio bearings obtained from two or more known radio stations. The intersection of the plotted bearings is the location of the aircraft at the time the bearings were obtained, provided, of course, that the bearings are not in error and that the elapsed time from one radio bearing to the next is small enough so that the distance traveled by the aircraft may be neglected. A third radio bearing is usually obtained as a check on the first two. The three bearings should intersect at one point but generally form a small triangle at their intersection. A comparatively large triangle obtained by plotting three bearings indicates that at least one of the bearings may be in error or that too much time has elapsed between successive bearings. In cases where appreciable movement of the aircraft has occurred between radio bearings, the approximate locations of the aircraft at the time each bearing was taken may be obtained by a simple graphic solution. A line is shifted on the map or chart, parallel to the heading of the aircraft, until the distances between the plotted bearings on this line correspond in order to the scale distances covered by the aircraft between consecutive bearings. This assumes that all bearings are equally accurate and that a uniform speed and direction of flight has been maintained during the time the bearings have been taken.

OBTAINING A POSITION "FIX"

The automatic radio compass enables the pilot to take two or more radio bearings very rapidly, which practically eliminates the consideration of the distance traversed between successive bearings. The procedure used in obtaining a position "fix" by radio bearings with an automatic compass may be of interest and will be described in detail. Either true bearings or magnetic bearings may be used for a position fix. In the example given below, the use of magnetic bearings and headings will be assumed, since practically all aerial navigation is based on the magnetic compass. The use of charts similar to the Radio Direction Finder Charts for Aeronautical Use prepared by the U.S. Coast and Geodetic Survey is also assumed. These direction finder charts have magnetic compass roses centered on the radio stations so that magnetic bearings may be easily plotted with a straight edge.

Two or preferably three known radio stations providing usable signals are chosen prior to the time the fix is to be obtained. Their frequencies or dial positions are noted in increasing or decreasing order so that tuning from one station to the next may be accomplished in a minimum of time. The directional gyro is caged to a corrected magnetic compass reading, and the aircraft is held as close as possible to this magnetic course. The heading must be held constant while the bearings are being taken.

The azimuth scale of the radio bearing indicator is then rotated until the zero index indicates the magnetic heading of the aircraft so that bearings referred to Magnetic North may be read directly from the azimuth scale. The radio station having the highest (or lowest) frequency or dial position is tuned in on the radio compass, and the reading of the bearing indicator is noted for this radio station. The radio compass is immediately tuned to the second radio station so that the radio bearing for that station may be obtained. The third radio station is tuned in and a third reading of the bearing indicator noted.

The three radio bearings obtained are magnetic bearings from the aircraft to the respective radio stations. Since the position of the aircraft is unknown, the bearings must be plotted from the radio stations. The approximate location of the aircraft is spotted on the Direction Finder Chart either by dead reckoning or by plotting the reciprocal radio bearings from the known radio stations. An accurate location is then de-

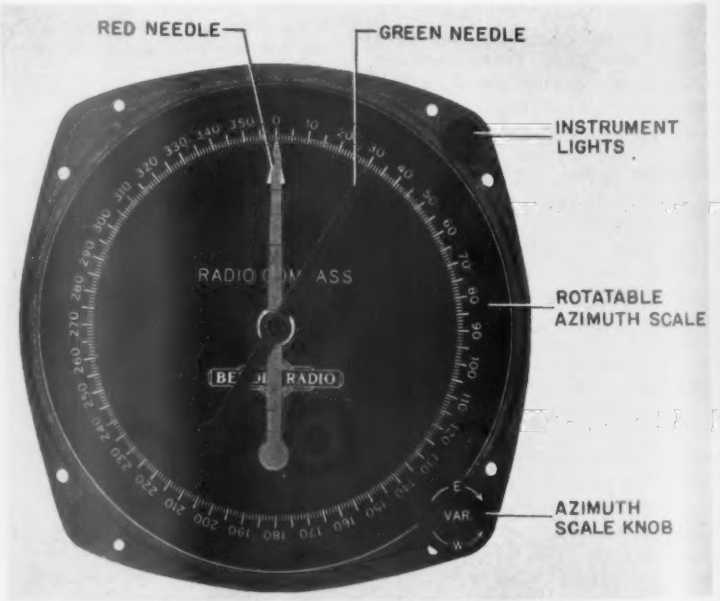

FIG. 6. Dual bearing indicator.

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NORTH AMERICAN B-25

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"The Development of the De-Icer" gives a brief explanation of: the causes and conditions of aircraft icing, what De-Icers are and how they operate. This short film shows the need for complete protection from ice.

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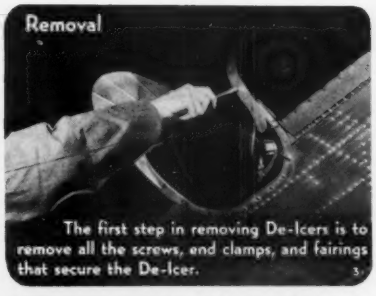
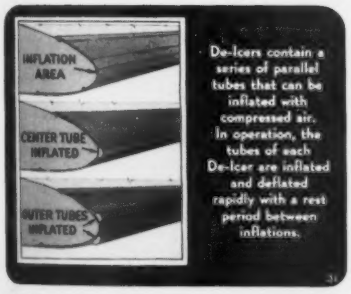
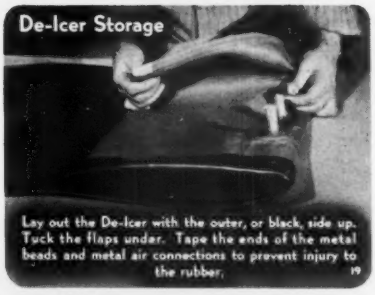
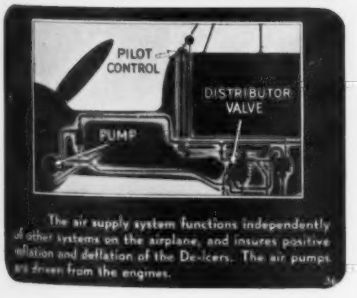
What causes the formation of ice upon aircraft?
Generally, two conditions must exist —
Visible moisture, and temperatures below +34 degrees Fahrenheit.
In engine induction systems, ice may form when temperatures are as high as +70 degrees Fahrenheit.




INFLATION AREA
CENTER TUBE INFLATED
OUTER TUBES INFLATED
De-Icers contain a series of parallel tubes that can be inflated with compressed air. In operation, the tubes of each De-Icer are inflated and deflated rapidly with a rest period between inflations.


De-Icer Storage
Lay out the De-Icer with the outer, or black, side up. Tuck the flaps under. Tape the ends of the metal beads and metal air connections to prevent injury to the rubber.


PILOT CONTROL
DISTRIBUTOR VALVE
PUMP
The air supply system functions independently of other systems on the airplane, and insures positive inflation and deflation of the De-Icers. The air pumps are driven from the engines.

Installing New De-Icers
To prepare the airplane for new De-Icers, apply adhesive tape over all skin laps and rivet heads in the De-Icer area to prevent localized wear on the undersurface of the rubber. Around salt water use a coat of P-27 primer on the skin under the De-Icer.

BOOKLET RÉSUMÉS

We have prepared pocket-sized booklet editions of the slide films. The booklets contain all of the individual pictures and accompanying reading text from the films. If you are now using the films as part of a regular instruction course, you will appreciate the opportunities these pocket-size booklets afford in further establishing De-Icer principles. We suggest you distribute copies of the booklet edition of the films to members of the audience for individual study.

HOW TO ORDER

Both the films and booklets are available without cost to qualified persons in the aeronautical industry who send in their requests on a company letterhead. When requesting the films, please tell us how many copies of the booklets you can use to advantage. Write to the B. F. Goodrich Company, Department 7191, Akron, Ohio.

In war or peace
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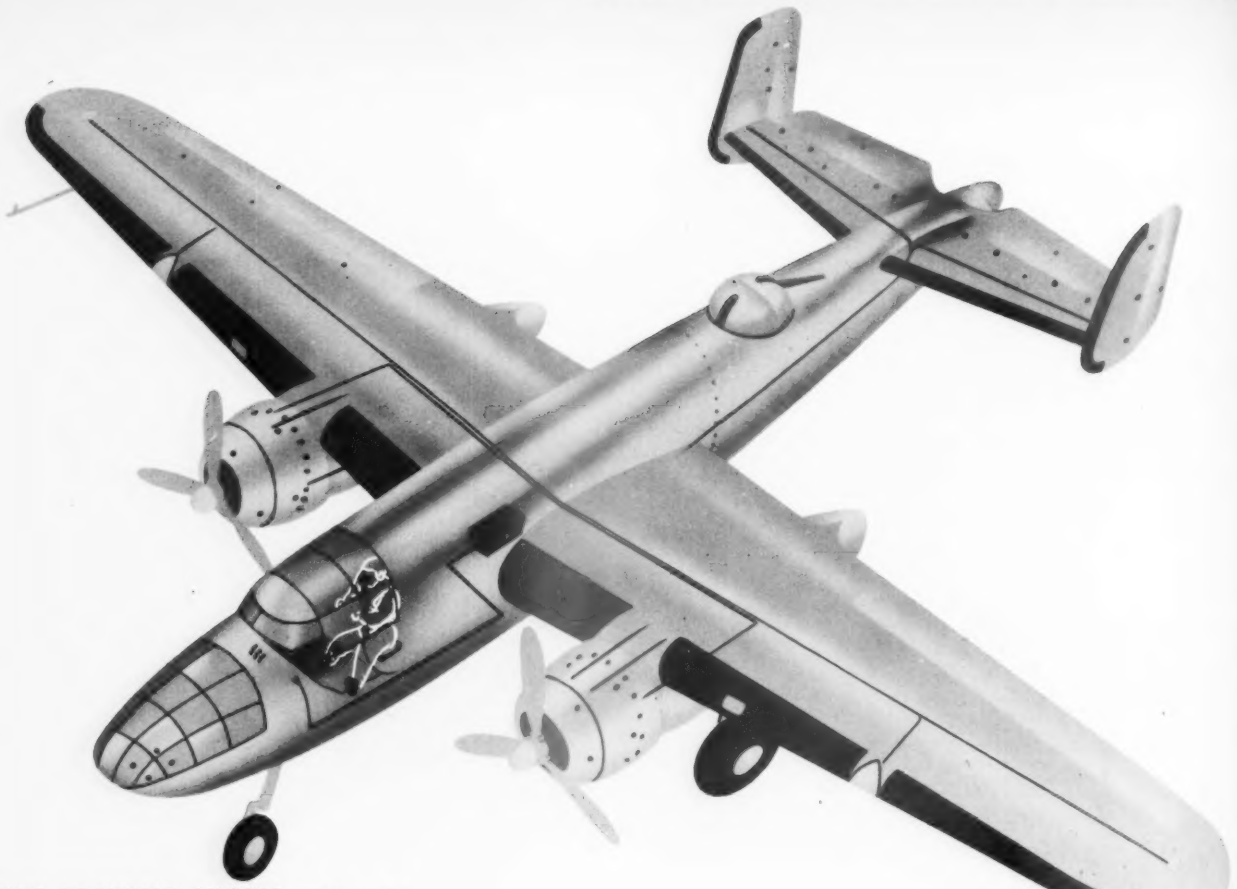
FIRST IN RUBBER

From the B. F. Goodrich Notebook



THIS DRAWING SHOWS where the B. F. Goodrich products are on a typical medium bomber. You will be able to distinguish everything from grommets to the De-Icers on the leading edge of the wings. In addition, bullet-sealing fuel tanks, carefully concealed for military reasons, are located in the plane.

B. F. GOODRICH SILVERTOWN TIRES help a student pilot achieve safer, smoother landings—thus building his confidence. You'll find tires bearing the famous name, Silvertown, on planes of all sizes, from primary trainers to huge 4-motor bombers, and on commercial planes and private planes as well. They help immeasurably to "Keep 'Em Flying"!

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termined by correcting the radio bearings for meridian convergence of the chart and for the difference in magnetic variation at the aircraft and location of the radio station.

Example

A location problem of this nature is shown in Fig. 5. For example, suppose the magnetic radio bearings from the aircraft may be 97 deg. to station "A" and 215 deg. to station "B." Plotting the reciprocals of these bearings from the respective radio stations indicates that the aircraft is approximately 140 miles west from station "A" and approximately 120 miles northeast from station "B." Examination of the Direction Finder Chart shows that a correction for meridian convergence of approximately 2 deg. must be added to the bearing for station "A," since the aircraft is west of the radio station. The magnetic variation is 1 deg. east at station "A," and slightly over 3 deg. east at the location of the aircraft. Hence, the difference in magnetic variation of 2 deg. must also be added to the bearing, since the variation is greater easterly at the aircraft than at the radio station. A value of 101 deg. is obtained after these corrections have been applied, which is the reciprocal of the magnetic bearing from station "A," to the aircraft.

Further examination of the Direction Finder Chart shows that a correction for meridian convergence of 1 deg. must be subtracted from the bearing to station "B," since in this case the aircraft is east of the radio station. The magnetic variation at station "B" is approximately 5 deg. east. The difference in magnetic variation of approximately 2 deg. must be subtracted from the radio bearing in this case, since the variation at the aircraft is smaller easterly than for the station location. The application of these two corrections to the radio bearing for station "B" results in a value of 212 deg., which is the reciprocal of the magnetic bearing from station "B" to the aircraft.

When the corrected reciprocal bearings of 101 and 212 deg. are plotted, respectively, from stations "A" and "B," the correct location of the aircraft is indicated at the time the radio bearings were obtained. The distance between the correct location of the aircraft and the approximate location first determined by plotting uncorrected reciprocal bearings is slightly over 11 miles for this particular example where the distance from the aircraft to each station is approximately 130 miles. In practice, a bearing from a third station "C" would be similarly corrected and plotted as a check on the procedure.

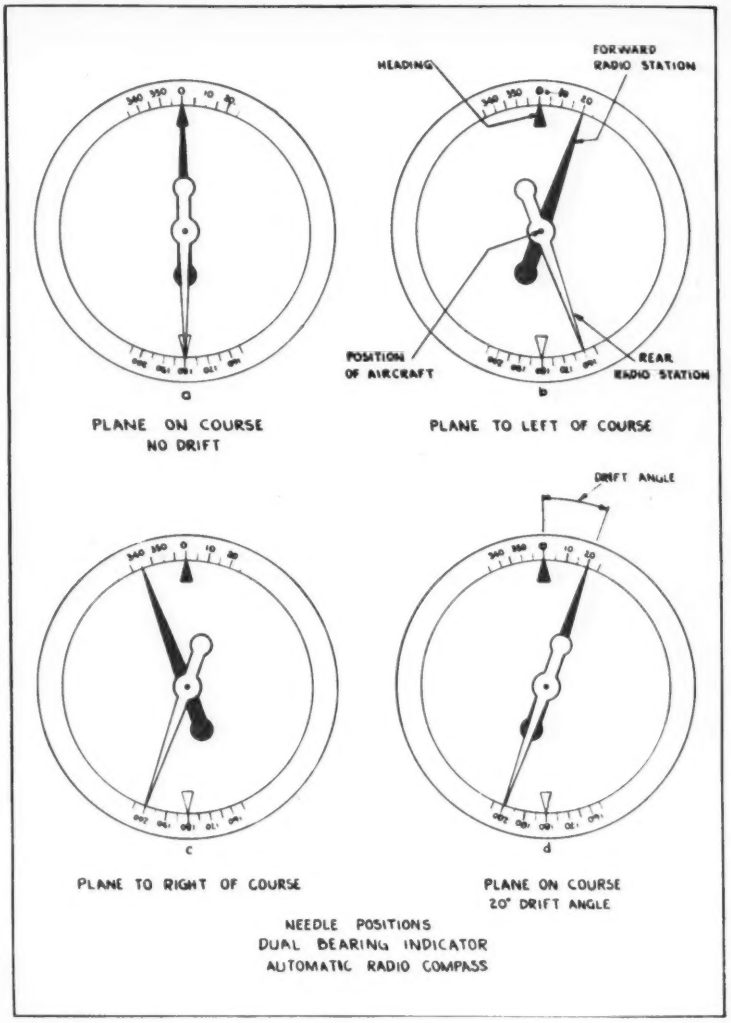


FIG. 7. Needle positions of dual indicator.

THE DUAL RADIO COMPASS

It has been mentioned that two of the main advantages of the automatic radio compass in comparison to other types are the speed with which bearings may be taken and the continuous indication of direction available to the pilot. These are important because the pilot is usually working under unfavorable conditions with respect to time and space when taking bearings and plotting position fixes on a chart. The pilot's problem is further simplified by the development of the dual automatic radio compass, which will be described briefly.

Two complete sets of automatic radio compass equipment are installed in an aircraft. The azimuth positions of the two loop antennas are indicated on a dual bearing indicator as shown in Fig. 6. The pointers are mounted concentrically on a common azimuth scale so that the bearings of two radio stations are continuously shown on the same indicator. The control knobs of one automatic radio compass and the corresponding indicator pointer are colored green in comparison to red for the controls and pointer of the second automatic radio compass. The complete equipment is calibrated and operated similar to the single automatic radio compass installation but has added advantages as an aid to aerial navigation.

One interesting and important use of the dual automatic radio compass is in flying a straight line between two given radio stations without the aid of other navigational instruments. This provides numerous possibilities for the opening of new air-line routes between cities not equipped with radio range facilities at present but where radio broadcast or beacon stations are located.

To fly a straight line between two radio stations, the pilot tunes in one station on each automatic radio compass and flys the aircraft to keep the two pointers diametrically opposite, as shown in Fig. 7a. The pointers have the

appearance of a double-ended pointer when they are exactly opposite. A simple indication of the position of the aircraft relative to the lines between the two stations is provided by visualizing the center of the pointers as the position of the aircraft and the ends of the pointers as the two radio stations. As long as the center of the pointer is on a straight line between the pointer ends, the aircraft is on a straight line between the two stations. If the pointers assume a position resembling that shown in Fig. 7b, so that the center is to the left of the ends of two pointers, the aircraft is to the left of the line joining the two stations. A condition similar to that shown in Fig. 7c would immediately indicate that the aircraft is to the right of the desired course. For cross-wind conditions, a heading of the aircraft is established by trial until the two pointers remain exactly opposite. The crab angle necessary to hold the aircraft on the straight line course is then read directly by noting the angular distance from the zero index to the pointer representing the station ahead of the aircraft. The red needle is generally used to indicate the forward station.

The dual radio compass may also be used to fly along the extension of a straight line between two radio stations. Thus, if the two stations were being approached along the extension of their common line and if the red needle represented the second station, only the green needle would appear. Upon passing over the first station, the green needle reverses to the 180-deg. position and remains opposite the red pointer. After the second station is passed over, the red needle swings to the position of the green needle. The two pointers stay in coincidence until the aircraft deviates from the extended line or until the pilot retunes the equipment associated with the red needle to a third station.

Recent Developments

One of the latest developments, not in production at present, is the combination of an automatic radio compass with a stabilized remote indicating magnetic compass. The two units are coupled to a common indicator. The remote reading compass is coupled to the azimuth scale of the radio bearing indicator, while the automatic radio compass actuates the pointer of the indicator. This combination affords a means of continuously and automatically indicating the bearing of a given radio station with respect to Magnetic North instead of the aircraft heading. Since magnetic radio bearings may be obtained directly from the indicator for any heading of the aircraft, the necessity of holding a predetermined aircraft heading for position fixes is eliminated. The device may also be used for flying an infinite number of radial courses toward or away from a single radio station, since there is only one line to the radio station having a given bearing with respect to Magnetic North. The stabilized remote indicating magnetic compass is a development of Pioneer Instrument Division of Bendix Aviation Corporation.

The automatic radio compass, including the dual automatic radio compass and the combination of the automatic radio compass with the remote indicating magnetic compass, offers unlimited possibilities in the field of aircraft navigation. As with any other navigation instrument, the final accuracy depends upon the calibration and the ability of the pilot or operator to interpret and apply the results obtained.

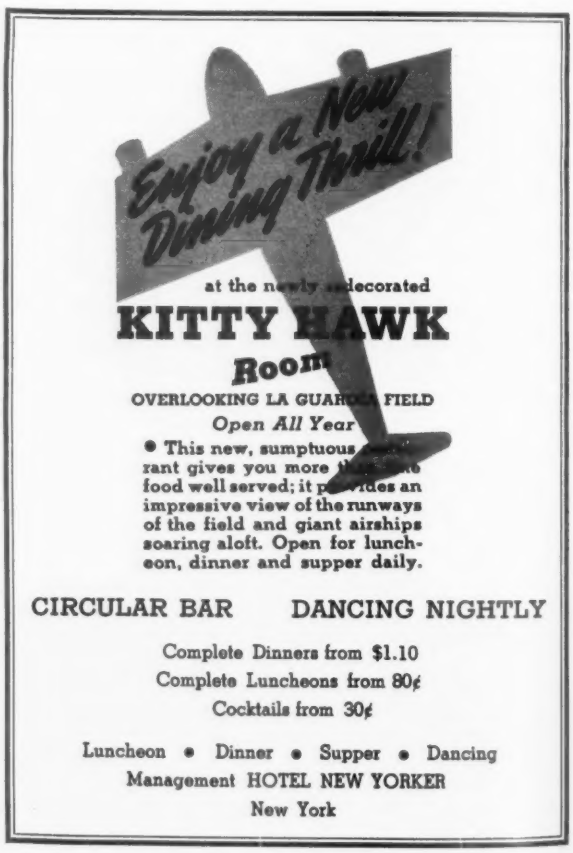
(*Continued from page 21*)

destroyed the conventional basis for European weather forecasting, which traditionally depended on the compilation of weather data from the west. Professor Bjerknes and his collaborators in Bergen developed a physical theory of weather sequence based on the identification of masses of moving air by means of high altitude soundings. This so-called polar-front theory solved a problem for Norwegian fishermen and revolutionized meteorology.

No one can know whether the enemy has found one of those fruitful paths of research that lead to revolutionary changes. But we certainly should compete with him in the search for it.

The prospect should be excellent for prompt utilization of the results of research in aeronautics since the American aeronautical industry has always been based on flexible production methods. After its enormous expansion in productive capacity by marriage with the automobile industry, this flexibility must not be lost. When the automobile industry produced a standardized article with a yearly model change, the retooling took a full twelve months. This is too long. The aeronautical industry works, not by a model or style year, but by a series of releases. When a design is first adopted, a definite number of planes are released for production. When sufficient improvements have been perfected, a further release is made, and so on. Thus there is continuous improvement of a product without interruption of production.

We must manage to incorporate our research results into our production in order to have both good airplanes now and better ones next year. Sustained research is an insurance that our airplanes can be individually superior to those of the enemy, and we surely can depend on American industry to produce them in superior quantity. Victory should follow from the quality and the quantity of these instruments of Air Power.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Aeronca Aircraft Corporation

WILLIAM D. HALL*

THE PRESENT COMPANY was founded as the Aeronautical Corporation of America in 1928, in Cincinnati, O., by a group of local business leaders. Jean Roché, then senior aeronautical engineer at Wright Field, and also on the original Board of Directors, designed the first aircraft, known as the Model C-2. This was a light plane in the original sense, as it was powered by a 26-hp. engine developed by Aeronca personnel and had a gross weight of 672 lbs. It was necessary to develop the engine, as well as the aircraft, at that time since there were no reliable engines available in the low horsepower range which were not prohibitive in cost. A photograph of this model is shown in Fig. 1.

As a two-place aircraft was demanded by the general public, the Model C-3 was produced. This plane was a development of the original Model C-2, using the original engine modified to produce 36 hp. A British-built version of the Model C-3 was used by the Englishman, David Lewellyn, to make the 10,000-mile flight from London to Cape Town in 130 hours flying time.

The Aeronca Model C-3 was replaced by the Aeronca low-wing model in 1936. This was the first moderately priced aircraft to offer the sportsman pilot a cantilever, low-wing airplane with a 500-mile cruising range at 125 m.p.h. This was also the first aircraft built by the company which did not use an Aeronca engine but used a 90-hp. Warner or LeBlond engine. Since the price of the low-wing model was somewhat higher than desirable for the general public and could not then be reduced because of the existing prices of engines of sufficient horsepower, the Aeronca Model K was developed in 1937, which again used the Aeronca engine redesigned to develop 45 hp.

* Chief Engineer.

FIG. 1. Aeronca C-2.

FIG. 2. Aeronca L-3B.

In 1938, Continental Motors, Lycoming, and Aircooled Motors corporations, developed four-cylinder, opposed, 50-hp. aircraft engines at a competitive price to the Aeronca engine. As the design and development of an engine require as much engineering time as an airplane, it was felt desirable to take advantage of the engine companies' experience and use engines furnished by them. The Aeronca Chief, using commercially built engines, was developed from the Aeronca Model K and was in active production until the present war. The Super-Chief has been widely used by sportsman pilots as a pleasure airplane and airport operators for training purposes. It was in a specially equipped Aeronca Chief that Johnny Jones made a nonstop, cross-country flight from Los Angeles to New York in approximately 30 hours in 1938.

In 1940 the Aeronca Tandem Trainer was developed to offer a suitable trainer to commercial and C.P.T. operators. This ship, slightly modified by increasing the visibility and adding equipment, was then purchased by the Army Air Forces for use as a liaison airplane. This plane, modified by replacing the engine with a pilot's seat, is being used as a three-place training glider by the Army Air Forces. A picture of the Army Air Forces version, known as the type L-3B, is shown in Fig. 2. A comparison of these photographs will show the development of the so-called light aircraft over a period of 13 years.

The primary engineering problems encountered in developing and building this type of aircraft are concerned with cost and weight control, in the order named, because of the public demand for maximum safety, dependability, and comfort at the least cost. The weight of the aircraft has been somewhat impaired by building to a price, since it has been necessary to use more inexpensive grades of material and types of construction, which are not always the most efficient from an engineering standpoint. Examples of this are the use of extensive amounts of SAE 1025 steel, a complete lack of heat-treated parts, and only a few castings or forgings—and these of a simple design. Tools and fixtures are kept to a minimum and, where possible, parts are standardized throughout on all aircraft in current production.

Year after year the light aircraft trend has been steadily toward a heavier, higher-powered aircraft at approximately the same cost, which, although it has not offered the general public the same aircraft for less, has offered more aircraft for the same price each year. Whether this is a correct trend or not will be shown only by future development.

TO KEEP 'EM LANDING...

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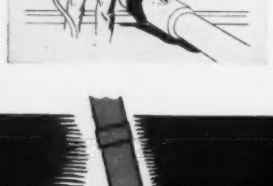
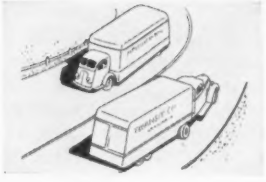
In the production of Cleveland Pneumatic Aerols*, which keep 'em landing safely and smoothly, all of the other Cleveland Pneumatic products play an important part.

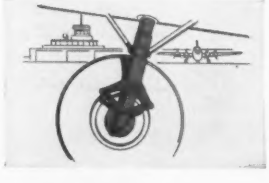
MINING. The first step occurs underground where Cleveland rock drills help extract the iron ore as well as the other minerals used in Aerols.



METAL WORKING. Later, Cleco pneumatic tools, such as chippers and grinders, aid in finishing the metal forgings from which Aerols are made.



TRANSPORTATION. Cle-Air shock eliminators help speed deliveries on many trucks transporting the raw materials and the parts for Aerols.



MANUFACTURING. Finally, at our own huge plant we manufacture the world-famous Aerols which are supplied for all types of airplanes.

Thus, from the mining of the metals to the time when the plane lands on Aerols, Cleveland Pneumatic products contribute to aviation's progress. The Cleveland Pneumatic Tool Co., Cleveland, Ohio.

AEROLS*

*THE SHOCK ABSORBING UNITS ON AN AIRPLANE'S LANDING GEAR; THE NAME IS DERIVED FROM THE WORDS "AIR" AND "OIL" — THE FLUIDS USED TO DISSIPATE THE LANDING SHOCKS

Aeronautical Progress at Bell Aircraft Corporation

RAY P. WHITMAN*

DURING the seven years of Bell Aircraft's corporate existence it has been necessary for our engineers to accomplish a considerable amount of aeronautical pioneering. Bell Aircraft was founded in the summer of 1935 and, with the exception of the many years of experience of the founders, the Company's principal asset was a single idea. Successful development of that idea since then has been largely responsible for many of the aeronautical advances which we have made.

Simply stated, the reason for Bell Aircraft was a conviction that military aircraft should be conceived as winged gun platforms, rather than as air vehicles on which guns were later to be attached. Translating this idea from theory into practical application was impossible with the aeronautical tools at hand. We had to pioneer in order to succeed.

Bell Aircraft's first airplane was the FM-1 Airacuda, a bimotored, long-range fighter, powered by two Allison liquid-cooled engines. What made it different from any airplane ever built was the fact that it mounted two flexible 37-mm. cannons. For the first time weapons with tremendous destructive power had been installed on a platform which could be flown a thousand miles or more to its target. It was this use of really heavy fire power in aircraft, as further exemplified in the Army P-39 Airacobra, which stands today as Bell Aircraft's greatest single aeronautical contribution.

The original decision to utilize a 37-mm. cannon left Bell Aircraft with many problems to solve, not the least of which were those having to do with harnessing effectively the terrific recoil forces of these cannon and of the 0.50-caliber machine guns, which up to this development had been unsuccessfully mounted as flexible weapons. How these problems were surmounted remains confidential military information today, but it may be said that recoil dampening equipment developed at the time the Airacuda was built is now widely used by the aircraft manufacturers of the United Nations.

Design problems faced during the development of the Airacuda prompted our decision to utilize extension drive shafts to carry power from the Allison engines to the pusher propellers. Parenthetically it should be reported that Bell Aircraft, by its experimental installation of an Allison in an A-11, was first to mount this engine in an airplane. Allison had previously developed a drive shaft design to be used in a dirigible installation of its engine, but again we were first in the field of plane builders when we used the drive shaft successfully. Experience gained with the Airacuda paid big dividends, with respect to the drive shaft, when we designed and built the Army P-39 Airacobra. The Airacuda shafts were approximately 5 ft. long. The Airacobra shaft is 10 ft. long and carries from the reduction gear box in the nose of the fuselage underneath the pilot to the engine in the rear. At this time I should like to reiterate Bell Aircraft's awareness that without the full cooperation and inspiration forthcoming from ranking U.S. Air Forces officers as well as such other organizations as Allison we could never have succeeded in our pioneering program.

Ray P. Whitman.

Another aeronautical first was our use of a constant strength beam in the construction of the FM-1 wings. This advance came from utilizing extruded, tapered spar caps and stressed aluminum alloy skin surfaces. The weight saving accomplished in this equalizing of the strength factors from root to wing tip was important. To fabricate the spar caps it was necessary for us to engineer new milling equipment, in itself an important production advance.

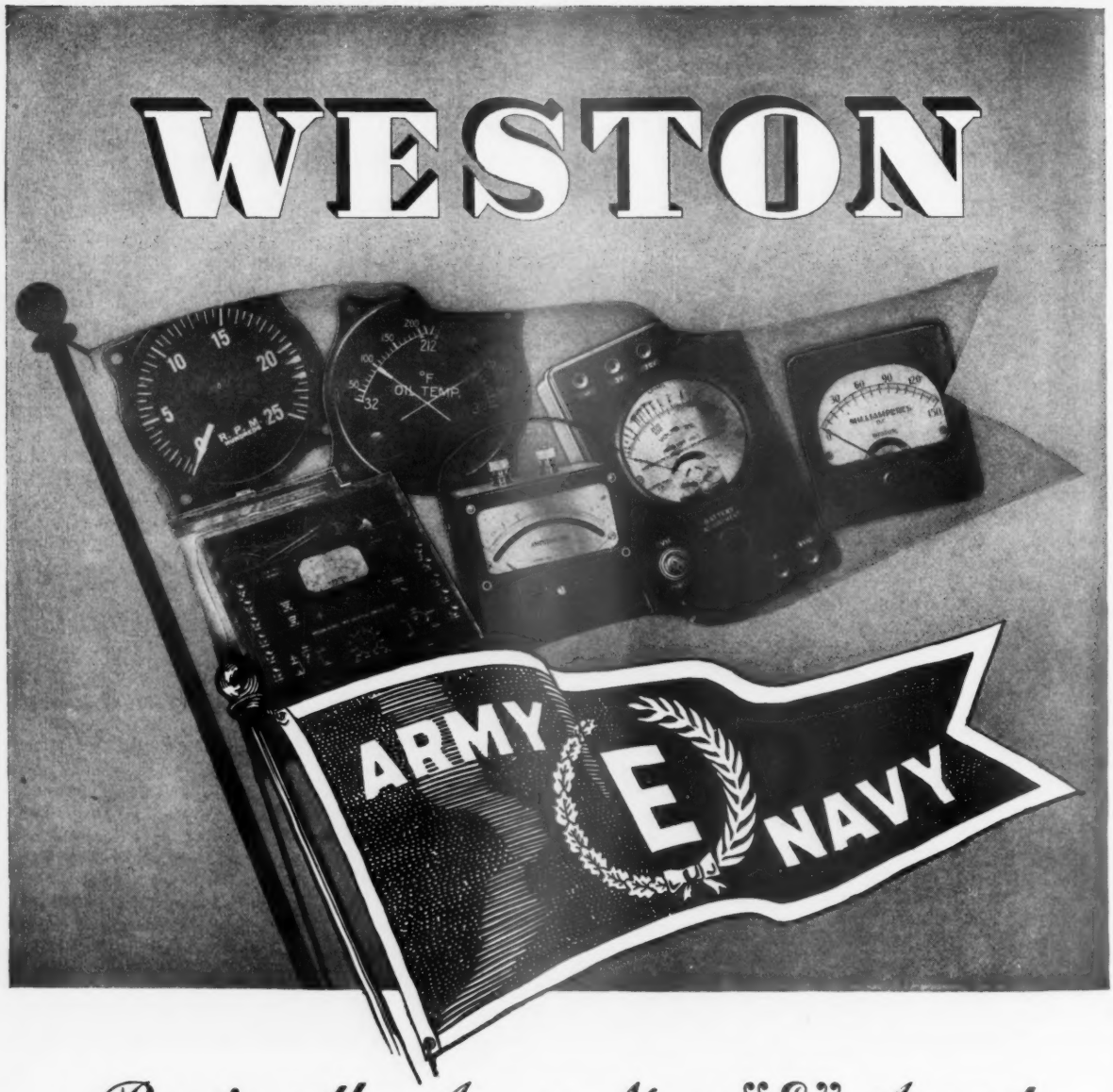
Bell Aircraft again pioneered in the aeronautical field by perfecting its use of the lofting principle to the point where pattern templates are made for all sheet metal parts, even those parts which later may be formed with complex curves. Here also, it was necessary to solve many subsidiary problems before we proved the fundamental soundness of this technique of 100 per cent lofting, and one of the most important of these secondary developments was a new method of making stamping dies, which enabled great accuracy in the manufacture of lofted parts. Space does not permit further consideration of this lofting principle and its use at Bell Aircraft except that we look upon this development as a keystone to our quantity production program. Because of lofting, the greater part of our fabricating and assembly work is now done by unskilled or semiskilled help, with but a few major fixtures and without the use of blueprints in the shops.

In the Army P-39 Airacobra, we made the first practicable use of buried radiators for cooling. Air is carried to the radiators by ducts which have their openings in the leading edge of the wings, inboard near the fuselage fairing. Important gains in cleanness of design were secured without impairing cooling efficiency. The National Advisory Committee for Aeronautics gave us assistance of the greatest value during our work on this and many other problems.

To mention but one more aeronautical contribution that Bell Aircraft has made, development of the tricycle landing gear for single-engined military aircraft stands as an accomplished fact. The advantages of tricycle landing gear, including elimination of ground looping and the ability to operate safely from improvised fields, more than compensated for the difficulties encountered.

Throughout the brief period that Bell Aircraft Corporation has been in business, we have sought always to maintain an awareness of the fundamentals of aeronautics. Beyond that, we have been unwilling to concede, because some particular aeronautical development—usually needed to accomplish a predetermined goal—had not previously been achieved, that it was impossible of attainment. Never once have we considered today's aircraft as a perfect, finished article. Our work has just begun!

* First Vice-President.



Receives the Army-Navy "E" Award

"On LEADERSHIP rests the responsibility for getting things done."

Only short months ago, the instrument goal in this mechanized war seemed unattainable. In almost unbelievable quantities instruments were needed for our huge plane program—for a two-ocean navy—for tanks, guns and walkie-talkies — for our arsenals and factories — and for countless new devices of war.

To approach this goal meant far more at WESTON than the mere addition of factory and laboratory equipment, and the usual worker-training program. It meant imparting to untrained hands the skill and instrument sense which ordinarily takes years to acquire. For it's this rare instrument sense, backing up sound engineering, which has been responsible for WESTON's continued leadership.

This "E" award to the workers at WESTON—the first to any group in this specialized field—means recognition of their efforts in striving to attain the goal in numbers, while never relinquishing the WESTON quality ideal.

And to our courageous fighting men everywhere, it conveys the assurance that they can depend on the men and women at WESTON to continue furnishing the essential instruments in ever increasing quantities . . . *until victory is won.*

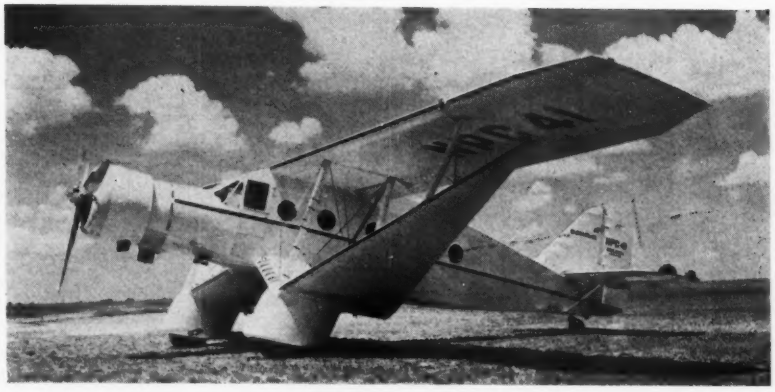
WESTON ELECTRICAL INSTRUMENT CORPORATION, NEWARK, N. J.

Bellanca Aircraft Corporation

ANDREW F. HAIDUCK*

THE HISTORY and technical development of the Bellanca Aircraft Corporation in the last decade have been associated with both civil and military aircraft, with the first eight years devoted largely to the design and development of civil airplanes, ranging from the three-place, twenty-miles-to-the-gallon Cruisaire for private flying to the two-ton Cargo Aircruiser suitable for cargo transportation in and out of areas not otherwise easily accessible. The year 1940 saw the development of the 0-50 liaison observation airplane and a gradual transition to the design and production of military aircraft components of all-metal construction. Before the fall of 1941, all commercial production had stopped and all of the facilities were assigned to the production of aluminum alloy floats, fins, tanks, boxes, etc., for Army and Navy bombers. The floats, fins, and tanks were engineered by Bellanca, whereas the other components were designed by the prime contractor. With the summer of 1942, came an expansion of facilities of well over 100 per cent. These new facilities will be devoted exclusively to the production of the Boeing twin-engined AT-15 crew trainer, an airplane constructed largely of nonstrategic materials, such as wood and steel tubing.

From 1932 to 1936, the Pacemaker and Skyrocket were progressively remodeled each year with such refinements as the addition of split flaps, cantilever landing gear, full N.A.C.A. cowling and other aerodynamic features powered with the Wasp engine. Several of these airplanes were delivered to the Bureau of Aeronautics for radio research. Featuring large load-carrying capacity, these airplanes were also used in many instances as general utility types. In the same interval were developed the Model 77-140 twin-engined convertible bomber and the high-speed long-distance racer, the Model 28-70. The former, powered with two 715-hp. Cyclones, had one of the first full feathering controllable pitch propellers developed in the United States, permitting take-off with loadings previously considered impossible, especially in the twin-float seaplane version. The 28-70, a wire-braced retractable landing gear, low-wing monoplane powered with 700-hp. twin-row Wasp Junior, was developed particularly for long-range flights. This airplane made the fastest transatlantic crossing up to that time when it crossed the Atlantic in 13 hours and 17 mins.



Model 66-76 Cargo Aircruiser.

The period from 1936 to 1939 was noted by the development of the 28-90 single-engined fighter bomber for export, the single-engined Model 66-76 Cargo Aircruiser, the Model 28-92 trimotor racer, and the Model 14-9 single-engined three-place Cruisaire. The Aircruiser, with its lower gull wing structure was approved for a cargo load of 4,020 lbs. Several of the latest version were used in the transportation of mining equipment and supplies in such widely separated areas as Canada, the Philippines, Cuba, and South America. The high rate of climb with load made this model particularly useful in mountainous areas where small fields and high obstructions are the rule.

The 28-92 trimotor racer was developed purely as a long-range racer and placed second in the transcontinental Bendix race from Los Angeles to Cleveland in 1939, with an average speed of 244 m.p.h. The Model 14-9 Cruisaire was developed in 1938 to meet the increasing demand for an economical three-place airplane. In the development of this type, two phases necessitated considerable research. The first resulted from dissatisfaction with the use of casein glue. This led to the detailed investigation of the entire field of adhesives and resulted finally in the development and use of a phenolic resin adhesive possessing greater strength characteristics and resistance to any deterioration by weathering or immersion in water. Its use required a large insulated room in which the glued joints were cured for a period of four hours at 140°F.

The other phase requiring an investigation in the development of this airplane is that of spin characteristics. A systematic spin test program with the actual airplane finally resulted in the elimination of the spin entirely. This was accomplished by a combination of additional tip fins and restricted controls.

In 1940, the 0-50, a two-place liaison observation airplane was developed for the Air Corps. A strut-braced high-wing monoplane, powered with the Ranger 420-hp. Vee engine, its salient features were its slow hovering speed of 24 m.p.h. and its ability to clear 50 ft. in 287 ft. These characteristics were obtained through the use of full span slats of latest N.A.C.A. type and partial span slotted dual flaps. Upon completion and delivery of three airplanes for service trial, engineering activity was allocated entirely to the design of an aluminum alloy D section type of fin of unusually light weight for use on an Army bomber and the design of auxiliary floats for a Navy bomber, etc.

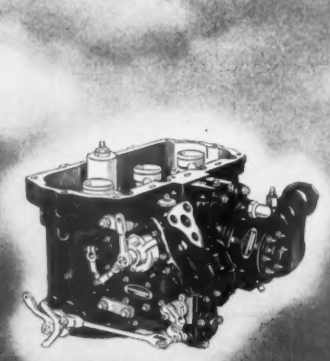
In September, 1941, all commercial production was stopped and production facilities were used entirely for the manufacture of component parts. These parts also included such items as plastic bomb bay doors and boxes. At present, scheduled production of all these components is operating at peak capacity. The receipt this spring of a contract to build the Boeing AT-15 twin-engined trainer in production necessitated an overall expansion of well over 100 per cent. The bulk of the activities of the organization during 1942 has been devoted largely to production engineering for the efficient production of old business on hand as well as the AT-15.

* Chief Engineer.

High Level
"PRECISION ATTACK"
with High-Level Precision Carburetion

On the first all-American "High-Level Precision Attack" over German-held territory, our bomber crews achieved their objectives. "STROMBERG" Injection Carburetors flying with them did likewise . . . supplied at high altitudes, as at all levels, precise metering and fuel economy essential to success.

"STROMBERG" Injection Carburetion is automatic. Its accuracy in proportioning fuel and air is unaffected by changes of speed, altitude or barometric pressure. Sound reasons, these, for the fact that "STROMBERG" Injection Carburetors fly with so many Allied flying men on missions ranging from patrol and convoy duty to "High-Level Precision Attacks"—and return.



THE INVISIBLE CREW
Precision Equipment by Bendix AVIATION CORPORATION

The "STROMBERG" Injection Carburetor is a vital member of "The Invisible Crew," which includes the precision instruments and equipment built by 15 Bendix Divisions and serving with our fighting crews on every front.

BENDIX PRODUCTS DIVISION

Ten Years of Boeing Progress

WELLWOOD E. BEALL*

THE HISTORY of the last ten years of engineering at the Boeing Aircraft Company is essentially the history of the B-17 Flying Fortress bomber. Called by General H. H. Arnold "the guts and backbone of our world wide air offensive," the Flying Fortress has more than borne out its builders' claims for it. Although the first of these all-metal four-engined bombers did not appear until 1935, design work, commenced in 1934, was based largely upon lessons learned in the engineering of the highly successful P-26 pursuit, the B-9 bomber, and the 247 transport.

A glance at the past ten years at Boeing brings to light the fact that in 1932 an order for more than 100 P-26 pursuit planes was in production. This tiny all-metal fighter served as Air Corps pursuit equipment for many years. It was the first all-metal monoplane pursuit plane in Army service and was at that time the largest order placed for pursuit planes in this country since World War I days.

Also being built was a group of twin-engined bombers, the all-metal B-9 monoplanes, which for the first time in Air Corps history provided our fighting service with a heavy bomber capable of keeping pace with pursuit planes. Out of this design came the 247, another all-metal monoplane, using two 550-hp. Wasp engines. This ship has served the nation's air lines for many years.

The B-17 emerged in 1935 as the nation's first modern long-range heavy bomber. It was designed wholly to Boeing specifications, with Boeing funds, and as a strictly private venture for an Army design competition. Design and construction of the first article was accomplished in nine months. So fast was this new airplane that new gun turrets had to be developed to shield the gunners from the force of a 250-m.p.h. slipstream. New Boeing-developed bomb racks were also installed which enabled various sizes of bombs to be carried with no change to the racks themselves.

As new variations of the B-17 appeared in following years, other projects were undertaken by the Boeing organization. Chief among these were the XB-15 Super Fortress, the Stratoliner, and the Model 314 Clipper. The XB-15 was, until the advent of the XB-19, the largest landplane in Army service. Features unique to this monster were walkways through the wings to each engine, a separate gasoline power plant for generating electric power, a complete 110-volt a.c. system, and complete sleeping and eating accommodations for the crew. This ship still holds International records of "Load," and "Altitude with load" as compiled by the F.A.I.

The Boeing B-17E.

As a development of the XB-15 and using the same wing design, the Model 314 Clipper was built. The first six were completed during 1938–1939 and delivered to Pan American Airways. The next year an additional six ships were built, three for Pan American and three going to British Overseas Airways. The Boeing Clipper is still considered the most luxurious passenger airplane in service and has a total carrying capacity of 89 persons, plus huge baggage and fuel loads.

Still building to the four-engined formula, a passenger-carrying version of the B-17 appeared in 1937. This ship, the Model 307 Stratoliner, was the first pressurized cabin commercial airplane in the world and thus was the first airliner to utilize the smooth, clear air of the substratosphere for passenger flying. Both T.W.A. and Pan American Airways ordered these ships for fast cross-country and intercontinent flights. Today the latest Fortress, the B-17F, is in large scale production at the Boeing plants and the plants of other aircraft manufacturers.

No mention of the Flying Fortress would be complete without a mention of one of its most vital parts—the turbosupercharger. In 1937 the first set of these units to be used on a four-engined airplane was installed on a Flying Fortress, the YIB-17A. Development and perfection of the device has continued unabated since this date. Boeing has also cooperated with other aircraft manufacturers in solving problems connected with turbosupercharger installations and other high-altitude problems.

High-Altitude Research

In high-altitude research Boeing has pioneered and had perhaps the first complete laboratory in the industry. A Strato-Chamber for the testing of new equipment as well as for the training of crew members has been in almost daily operation since May, 1940. Tests with a smaller low-pressure chamber were in progress since 1937. Also in use is a section of this Strato-Chamber which can be lowered in temperature as well as pressure and which also has a variable humidity feature. A larger low chamber, where Fahrenheit temperatures can be held indefinitely, is used to test whole gun turret assemblies, bomb racks, and miscellaneous equipment. Costs on testing of new equipment have been brought down considerably by this method. Final proof testing of course still remains in the able hands of the Boeing Flight and Aerodynamics Division, which maintains a number of specially equipped B-17's for experimental work of all kinds.

One outstanding development of the past ten years has been the adoption by the Boeing Company of the distinctive dorsal fin found on all current Boeing models. This long, sweeping vertical tail has made the B-17 stable throughout all conditions of flight. Even when flying with two engines on the same side out of commission, the B-17 can fly smoothly and easily without strain on the pilot. In the event of engine failure under low-speed conditions, the dorsal fin counteracts dangerous yawing tendencies.

Constructed during the past year was the Boeing XPBB-1, a large patrol bomber flying boat. Although in the four-engined weight class, the XPBB-1 had but two engines. Unusually good hydrodynamic and aerodynamic results have been obtained with this boat.

Today we are thinking in terms of higher wing loadings, greater gross weights and all-over refinements in design. The work done by the Boeing Company during the past ten years has been primarily concerned with the development and perfection of large multi-engined airplanes. The future is difficult to foresee, but, because of the success of designs originated along these lines to date, it seems safe to forecast a continued development of large airplanes in the next ten years.

* Chief engineer, Boeing Aircraft Company.

You Cannot See Me–

I am not only invisible –

I am also indivisible –
and universal.

I am all about you –
and even inside of you.

Without me you cannot live.

No one knows how large I am –
yet I am many times larger than the earth.

People know far less about me than they do of land and water.

Yet I am the same to everyone, everywhere: a common denominator in the lives of all living persons.

I make it possible to abolish isolation, to re-shape geography, to erase boundaries, to eliminate the handicaps of distances and the surface barriers that have encumbered "earth-bound generations."

The use of me makes close neighbors of all races all over the globe.

As more people understand and utilize me, they can enjoy an entirely new kind of world.

My world is even more different than the "round" world in comparison to the ancient "flat" world.

People are just beginning to explore my possibilities, yet already I have changed age-old military strategy.

I make possible even greater changes in every phase of human relationship.

No one can .hide from me, because I am omnipresent.

I am man's greatest physical challenge and greatest opportunity in all history.

My name is "AIR."

It is not enough simply for "aviators" to comprehend me.

My value is in exact ratio to the number of people, in all walks of life, who capitalize on me. Because I affect every living person everywhere; every government; every creed; every tongue; every industry; every market; every inch of the earth's surface.

You can use me right now, here at the home front, just as our Army and Navy are doing on distant battle fronts. By so doing, you can save time and expedite your contributions to our nation's war effort.

My importance now, as a realm for military maneuvers, is only a hint of how I can benefit everyone, and make possible a much better world.

AMERICAN AIRLINES *Inc.*

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ROUTE OF THE FLAGSHIPS

Brewster Aeronautical Corporation

RAY HILL

DEVELOPMENT of famous fighting aeroplanes by Brewster is a success story unmatched in the industry. For just ten years ago Brewster was only a well-known name in float construction when it embarked upon its present ambitious program.

The famous Brewster Blasters—devastating dive bombers—are known to the United States Navy as the Buccaneers and to the British as the Bermudas. The Brewster Battler will add to the glory achieved by the famous little Buffalo in Finland, Russia, India, and in the South Seas.

Airplanes were unheard of back in 1810 when James Brewster started his horse carriage factory at New Haven, Conn. James Brewster's carriages were of such excellent construction that his fame quickly spread and in 1826 he opened a New York branch on Broome Street, Manhattan.

About the middle of the nineteenth century Brewster moved to 47th and Broadway, Manhattan, and contunued to win carriage-making prizes until it entered the automobile coach-work field in 1907. Brewster auto bodies won such renown that in 1910 the company once again was forced to seek new quarters, this time moving to Queens.

Brewster's first step into the aeronautical field was made at the Queens plant in 1920 when a Navy contract for Duralumin seaplane floats was undertaken. More float work followed, in Duralumin, wood and stainless steel. Then, in 1924, the Brewster Aviation Division produced the first racing motor boat manufactured in Duralumin, the President's Cup victor, Cigarette IV.

Brewster was recognized as one of the best float producers in the world and in 1932 it was reorganized under the name of Brewster Aeronautical Corporation.

One of the new organization's first moves to build a complete airplane was the conclusion of an arrangement with Consolidated Aircraft Corporation whereby Brewster gained all design and manufacturing rights to the famous Fleet 16F commercial trainer and the military model 21. This trainer was used in the United States by both the Army and Navy for training purposes and was adopted by 17 foreign nations as standard training equipment.

Eventually Brewster's aircraft expansion reached the point where new facilities were so badly needed that the company took over an eight-story building.

Here Brewster began producing the little Buffalo Fighter, which at the start of the war won unstinted praise for its speed, maneuverability and fire power. But before long the company again had outgrown itself and in 1940 discovered that additional space was needed.

A big manufacturing plant was obtained at Newark Airport where Brewster began manufacturing wings and floats for the huge Consolidated PBY's as well as completing the assembly on the Buffaloes.

Brewster Buffalo fighters undergoing final flight tests.

It was only a few months later that the dive bombers now known to the Navy as the Buccaneers and to the British as the Bermudas were developed. To build these hard-hitting, two-seater, mid-wing monoplanes, still greater and more modern plant facilities were needed. A site was obtained and a new assembly plant was constructed.

But this, too, proved insufficient when Brewster began turning out what British pilots have called "the finest dive bombers in all the world." The plant was doubled in capacity and hundreds of dive bombers are rolling along the production lines.

While it was obtaining these sites the company also had leased several smaller buildings near its two big plants on Long Island. Yet these proved to be entirely inadequate as Brewster pressed to keep pace with the American war effort.

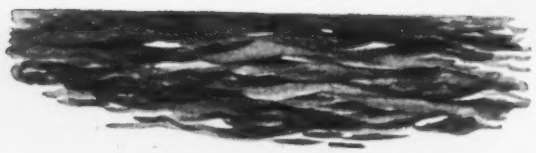
A new fighter contract was accepted from the United States Navy and again it became necessary to find space to handle these in their primary stages. So, in October of 1942, Brewster took over still another building in which to house machinery necessary for turning out Fighter parts.

Fighter planes (Buffaloes) are in action with the United States Marines, and dive bombers (Bermudas) with the R.A.F. in Britain.

Thus from a carriage manufacturing concern in 1810, Brewster had advanced with the times through the horse and automotive transportation fields into the aircraft industry where, within the last ten years, it has developed from a manufacturer of aircraft floats and training ships to the builder of the world's outstanding fighting aircraft—Buccaneer and Bermuda dive bombers and Battler fighters.

Brewster Bermuda dive bomber—Great Britain.

DOW



TRADE DOWMETAL MARK

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

THE SUCCESS of Dow technicians in extracting magnesium from sea water came at the very time when it was most needed for fighting aircraft and other weapons for our armed forces. But the ultimate wider applications of this extraordinary weight-saving metal carry far-reaching social implications. Industrial designers will see endless possibilities for usefulness in the vast quantities of magnesium to be available when Victory is won. Out of their imaginations will come applications affecting every phase of American life.

MAGNESIUM

The Lightest Structural Metal . . . One-third Lighter Than Any Other in Common Use

Consolidated Aircraft Corporation

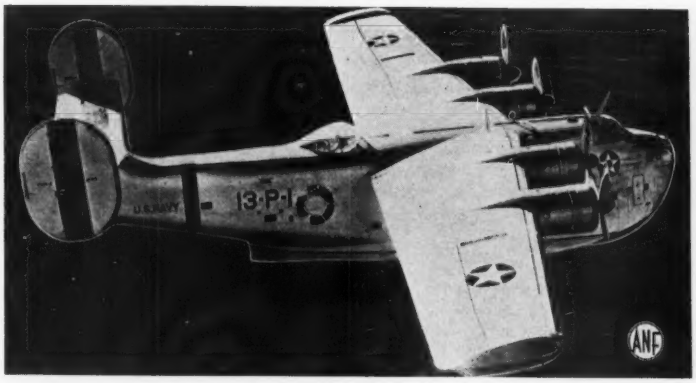
H. A. SUTTON*

DURING THE PERIOD when Consolidated Aircraft Corporation was attaining its present position—a leading manufacturer of long-range flying boats and land-based airplanes—it made many important contributions to the basic aeronautical science.

In 1932, Consolidated's engineering staff designed the first U.S. Navy patrol airplane using an aluminum-alloy, metal-covered, full cantilever wing, employing stressed-skin construction. This was the original model of the PBY series Catalina two-engined patrol bombers. The light structural weight and hydrodynamic qualities of this airplane were such as to permit its continued development in production over a ten-year period, with constantly increasing performance. Consolidated developed the retractable float for this airplane which reduced drag in flight and appreciably increased its range. Installation of a tricycle gear made it also the world's most successful amphibian. A contributing factor to the long-range flight ability of PBY's lies in the design of the wing structure to carry fuel, thereby saving much weight normally required for separate fuel tanks.

The study and use of high wing loading permitted greatly increased range, and high speed and cruising performance were improved to a considerable degree. Cruising performance was further improved by development of an airfoil section having remarkable low drag in the cruising range of lift coefficients. The concurrent development of more efficient high lift devices provided low landing and take-off speeds. The results of this research culminated in development of the B-24 Liberator bomber.

The development of higher wing loadings made the problem of producing a hydrodynamically stable flying boat more acute. Consolidated engineers met this demand by developing a means of tank testing, whereby the hydrodynamic stability characteristics of its flying boats could be predetermined through the use of dynamically similar models, as contrasted with the former use of tank models that were only geometric hull reproductions. Through the use of dynamically similar models, Consolidated was able to predict accurately all hydrostability characteristics of its full-scale flying boats. By the application of power, these dynamically similar models were actually flown off, and landed on, water; in consequence, longitudinal, directional, and spray characteristics, skipping and porpoising, as well as drag and moment data were determined. The certainty of satisfactory full-scale hydrodynamic performance was thus greatly increased.



The Consolidated PB2Y-2, powered by four Pratt & Whitney engines.

With mounting aircraft production keyed to purposes of war, the rapid development of new airplane designs has become of paramount importance. In this connection, Consolidated takes pride in recalling the 305 days following July 11, 1938. On that date, authorization was given to proceed with the design and construction of the Model 31 Consolidated Long-Range Patrol Boat. On May 5, 1939, just short of ten months later, the first flight test of the XP4Y-1 was made. Never before had an experimental airplane of such size been produced in so short a space of time. Previous experience in the building of large multiengined experimental aircraft had led manufacturers to accept the belief, that from two to three years, or even longer, were necessary for the development of "prototype" airplanes. Consolidated, through a splendid demonstration of cooperation between its administrative, manufacturing and engineering departments, proved the fallacy of this belief.

In order to meet the ever-increasing demand for greater load-carrying capacity, Consolidated engineers have developed processes to improve the physical properties of aluminum alloys, thereby increasing strength and reducing weight. A secondary heat-treatment of Alclad 24ST has been evolved, whereby the tensile yield strength is increased approximately 11 per cent and the compressive yield strength, 38 per cent. By another process, cold-worked Alclad 24SO is heat-treated and then stretched to a permanent elongation of $3^1/_2$ per cent, thereby increasing the compressive yield strength approximately $21^1/_2$ per cent. The combination of these processes produces a material with 50 per cent increase in compressive yield strength. This is obtained without increased susceptibility to corrosion or decrease of elongation beyond a safe factor.

Other contributions that have attained general use in the industry are:

The development of a process for impregnating plywood with a phenol-formaldehyde resin that has been adopted by several manufacturers of plastic plywood parts for aircraft.

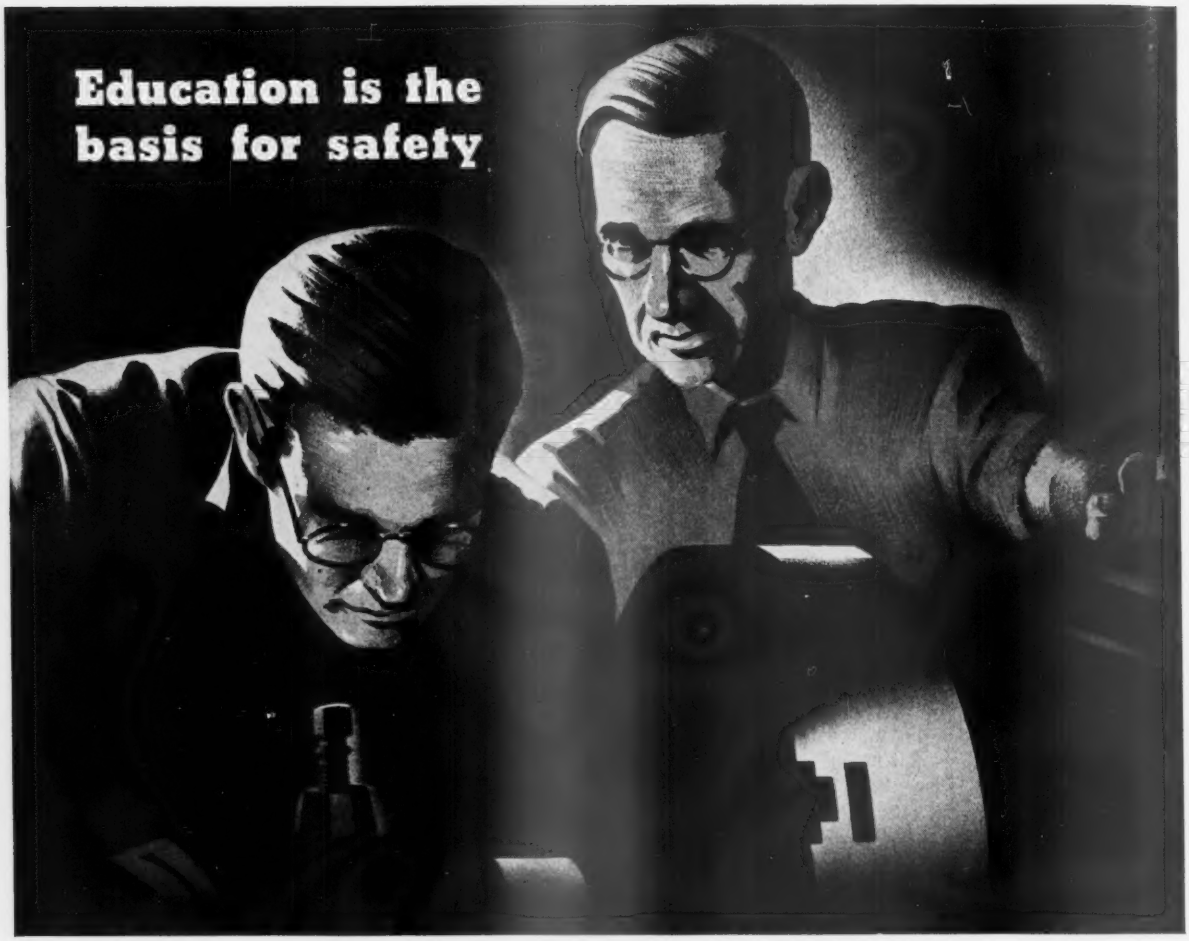
Gauges of the electric-wire-resistance type, known as "Celstrain" gauges, have been developed to indicate bending, axial and shear stresses. The use of these gauges greatly facilitates accurate structural testing.

A method to permit more precise design of plate girder beams, based on many years of research and experimentation, has been shared with the industry and adopted by the U.S. Army Air Forces.

Proper operation of large airplanes has been aided and safeguarded by the development of a circular slide rule known as the "Bal-o-dial," which is used to determine the longitudinal balance and the effect of changes in loading.

During the present emergency Consolidated's every resource has been mobilized to meet wartime demands. All the experience and ability of its engineering staff are devoted, at a greatly accelerated pace, to producing superior military airplanes.

* Director of Engineering.



Information supplied by the National Safety Council

Labor, particularly inexperienced labor, cannot be expected to recognize the full penalties of carelessness in the shop. Management has assumed the responsibility of supervising safety measures, and has cooperated in establishing sound safety rules.

Nevertheless, the large increase in labor personnel due to war needs, plus the influx of inexperienced men, have resulted in a substantial increase in lost time accidents.

Even assuming that the obvious safety measures with regard to operating machinery, electrical equipment and shop traffic have been installed, two factors — education and eternal vigilance — determine the real effectiveness of any safety program.

Both are the responsibility of the supervisory staff, from foremen up. The foreman who does a thorough job of educating his particular group in safety rules and cooperative enforcement has done much to cut down accidents. Management that takes an active interest in both safety education and the enforcement of safety measures has taken a great step forward in reducing wastage of irreplaceable production time.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company
500 Fifth Avenue • New York City

MOLY

Curtiss-Wright Corporation

ARTHUR V. LINDEN

IN THE TRADITION of its pioneering record, Curtiss-Wright Corporation has greatly advanced its program of research, engineering development and manufacturing processes in the field of aircraft, engines and propellers during the past ten years. Under the leadership of its president, G. W. Vaughan, a graduate of the automotive industry and an exponent of standardization in mass production, the organization was the first company in the aviation industry to actively incorporate automotive production processes in its field.

Its major technical developments probably can best be traced through the daily war communiqués as to the performance of its products over every war front . . . by observing the record established by the Curtiss Warhawk, Kittyhawk and Tomahawk fighters produced by the Curtiss-Wright Airplane Division . . . by noting the prowess of the more than 100 military aircraft types powered with the Cyclone and Whirlwind engines manufactured by Wright Aeronautical Corporation . . . by checking the reports on those combat planes equipped with Curtiss electric propellers produced by the Curtiss-Wright Propeller Division.

CURTISS-WRIGHT AIRPLANE DIVISION

The Curtiss-Wright Airplane Division, in addition to pioneering in the development of pursuit, dive bomber, scout observation and the first commercial transport sleeper plane type, designed and produced the Curtiss P-36 pursuit model, also known as the Curtiss Hawk 75, which was widely operated with success by the French during the early days of the war. This was followed by the now famous P-40 line of fighters.

More recently, this Division has put into production for the U.S. Navy the newest of its long lines of dive bombers, the Helldiver, a fast, far-ranging, heavy bomb-carrying type which the U.S. Navy and British experts have termed the most powerful dive bomber in the world. In addition, it has climaxed a long period of experience with transport planes by developing and putting into production for the Army the new Curtiss (C-46) Commando. The new Curtiss (SO3C-1) Seagull scout-observation type is being produced for the Navy, and several trainer models for both services.

During the last decade, it has led the field in developing unique armament installations for fighter aircraft, in perfecting bore-sighting methods and in the use of plastic materials in ammunition boxes, chutes and many other armament parts. Its lofting techniques were a major factor, for example, in the successful development of the 0-52 observation type directly from design to production without the usual prototype; its offset printing method of making loft templates is another recent contribution.

WRIGHT AERONAUTICAL CORPORATION

Wright Aeronautical Corporation, concentrating upon the production of air-cooled radial engines, has in the past ten years evolved many technical advances leading to improved engine performance, increased horsepower and more efficient methods of manufacture. Illustrating this, the first Cyclone engines developed about 60 hp. per cylinder, whereas new methods of casting deep fins on cylinder heads enable the Cyclone of today to provide about 135 hp. per cylinder.

A recent technical achievement is the development of the forged aluminum alloy cylinder head, together with methods for its mass production. Use of the new type head makes it possible to increase engine horsepower from 12 to 15 per cent without any increase in weight. The forged head makes possible for the first time a service engine weighing less than a pound per horsepower.

The two-speed supercharger, developed by the Wright Aeronautical Corporation, retains the efficient operation of both military and commercial aircraft to much greater altitudes than is possible with the single-speed supercharger.

Highly important in the building of more powerful engines was the introduction of the Wright dynamic damper. This damps out the torsional vibrations of the shaft. In the same field, the dynamic suspension of engines to an air frame or engine nacelle was a production of the Wright Aeronautical engineers.

Wright Aeronautical introduced the planetary reduction gear system, providing reduction gearing at any desired ratio with a minimum of added weight. Perfection of a technique for casting magnesium made possible the use of this lightweight metal for such engine parts as nose sections, supercharger housings, covers and oil pumps, thus contributing to lowering the horsepower-weight ratio.

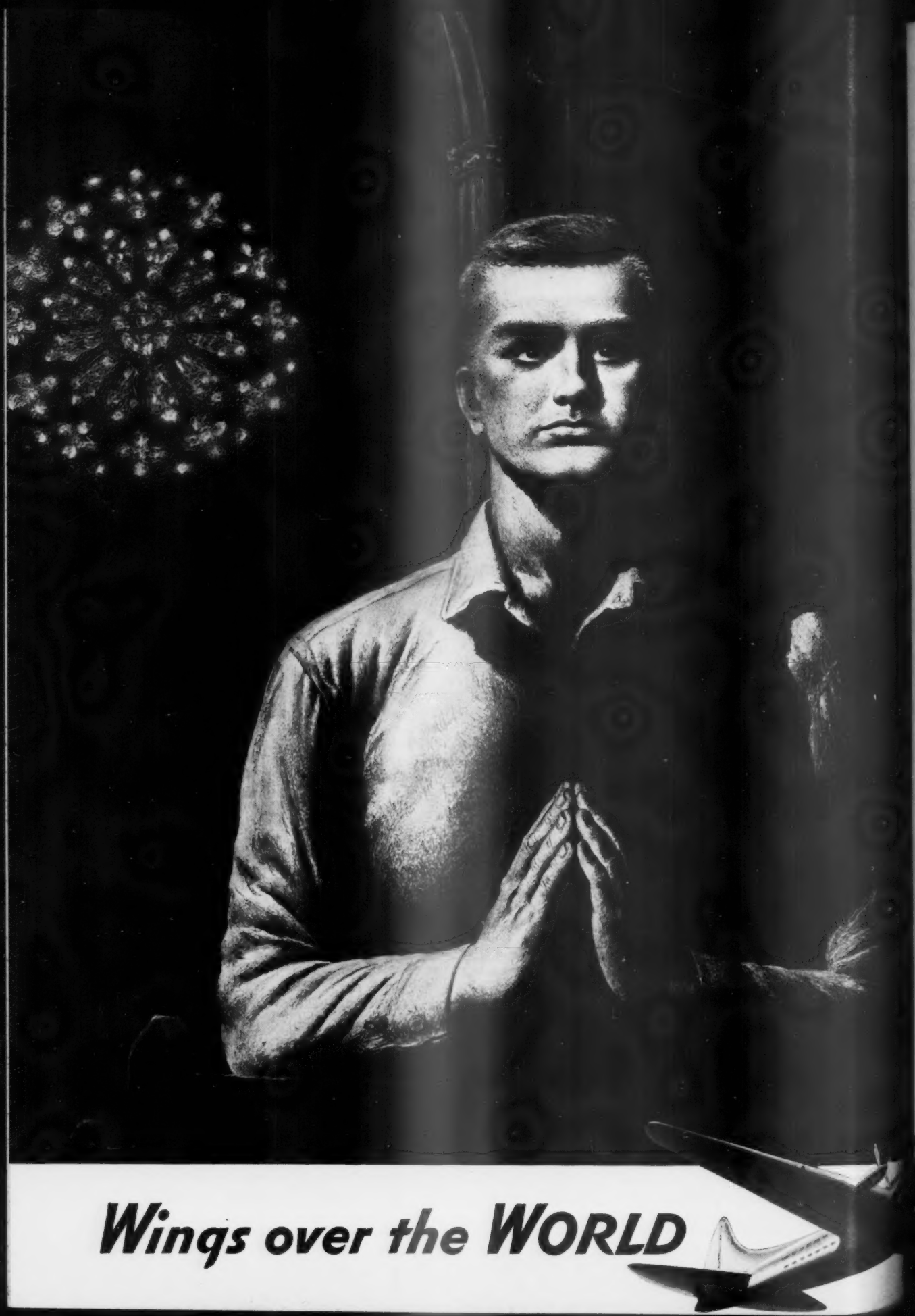
The research laboratories also produced methods of hardening cylinder barrels, gears and other engine parts by a nitriding process, making it possible to increase the service life and take more power from the engine without increasing the size and weight of steel parts. An invaluable aid in flight operations is the torque meter, designed by Wright engineers. This meter measures the torque reaction on the stationary reduction gear.

Another recent technical improvement is the replacement of sheet aluminum baffles and push rod housings with plastic baffles and housings.

CURTISS-WRIGHT PROPELLER DIVISION

The Curtiss-Wright Propeller Division has made numerous developments in the design of its Curtiss Electric propeller during the past ten years. This division developed the first successful controllable-pitch propeller in the world and also, especially for use on the Bell Airacobra, a "hollow shaft" propeller that permits an aircraft cannon to be fired through the hub.

Reversible-pitch propellers were pioneered. Automatic synchronizer controls, which result in tighter operation and relieve the strain on the pilot, have been adopted as standard equipment on such large flying boats as the Consolidated PB2Y-2. The division has spent considerable time and energy in the development of the hollow steel blades. Blade shank cuffs have also been developed. These cuffs assist in improved air cooling of engines and also help to reduce shank drag. With increased demand for faster airplanes, the division has especially developed four-bladed propellers. Around these propellers have been built the Martin B-26 and the Republic P-47 Thunderbolt. Recently, the division pioneered the largest propeller of its type for a new Navy flying boat, using in this instance extremely long hollow steel blades.


Wings over the WORLD

"The FULL development of Individual Personality"

...a 6 point post-war program by THE ARCHBISHOP OF CANTERBURY

What kind of a world are we fighting to create?

Pan American has presented answers to this question by America's great philosopher, Dr. John Dewey, and by Dr. Hu Shih, recently Chinese Ambassador to the United States.

Herewith we present a statement written for Americans and people throughout the world by the Most Reverend William Temple (Cantuar) the Archbishop of Canterbury.

THE STRUCTURE OF LIFE as we knew it before the war has already been profoundly modified. How far do we want to restore it if we can?

The task of the Church in face of social problems is to make good Christian men and women. That is by far its most important contribution.

But it is also part of the duty of a Christian to judge how far particular evils are symptoms of a disease deeper than the evils themselves.

There is nothing wrong about profits as such. It has always been recognized that both the producer and the trader are entitled to a profit which they have earned by their service to the community. But it is possible, nonetheless, for these two to get in the wrong order. Then the consumer is treated only as a *means* to success . . . *whereas* he ought to be considered the whole end of the process.

If that is true, it is the duty of Christians to become aware of it and to demand a remedy. I offer these suggestions as a goal to aim at immediately:

(1) Every child should find itself a member of a family housed with decency and dignity, so that it may grow up in a happy fellowship unspoiled by under-feeding—or overcrowding, by dirty and drab surroundings or by mechanical monotony of environment.

(2) Every child should have the opportunity of an education till years of maturity. This education should be inspired by faith in God and find its focus in worship.

(3) Every citizen should be secure in possession of such income as will enable him to maintain a home and bring up children in such conditions as are described in paragraph 1 above.

(4) Every citizen should have a voice in the conduct of the business or industry which is carried on by means of his labour, and the satisfaction of knowing that his labour is directed to the well-being of the community.

(5) After the war, every citizen should have sufficient daily leisure, with two days of rest in seven, and an annual holiday with pay, to enable him to enjoy a full personal life.

(6) Every citizen should have assured liberty in the forms of freedom of worship, of speech, of assembly, and of association for special purposes.

Utopian? Only in the sense that we cannot have it all tomorrow. But we can set ourselves steadily to advance towards that six-fold objective. It can all be summed up in a phrase: *the aim of a Christian social order is the fullest possible development of individual personality in the widest and deepest possible fellowship.*

* * *

I should give a false impression of my own convictions if I did not here add that there is no hope of establishing a more Christian social order except through the labour and sacrifice of those in whom the Spirit of Christ is active.

† † † William Cantuar:

ARCHBISHOP OF CANTERBURY

Never before in the world's history has the "brotherhood of man" been so close to reality as it is today.

For, the instant we win this war, all *geographical* barriers will disappear. The "foreigner" who used to be strange and different because he lived across an ocean, will become as familiar to you as the man in the next town. London and Paris will be ten hours from New York —Chungking, China, twenty hours from San Francisco.

And this travel will not be just for the well-to-do. Pan American's knowledge of technological improvements (based on more than 120,000,000 miles of overseas flight) indicates that air travel costs will be brought down within reach of the average man and woman.

Today, of course, Pan American's every transport facility is working overtime to help make possible the Victory on which all our plans for a better world must be built.

PAN AMERICAN WORLD AIRWAYS SYSTEM

PAN AMERICAN CLIPPERS

10TH ANNIVERSARY

Congratulations-

1932-1942 . . . certainly, in world history that period will go down as "The Air Decade."

Into the past ten years have been crowded so many advances in the design and performance of aircraft that it has been difficult to report them all. But fortunately, in the field of aeronautical engineering, there has been a publication equal to the task . . .

To Aeronautical Engineering Review—commemorating the Tenth Anniversary of the Institute of the Aeronautical Sciences founded in 1932—goes the congratulations of the entire Eastern Air Lines Organization.

Keep up the good work!

Douglas Aircraft Company, Inc.

ROBERT NEVILLE

ALMOST ten years ago to a day, Donald W. Douglas took a decision that was to revolutionize world transport aviation. It was to bid on a T.W.A. demand for a commercial transport plane.

For ten years, since his first contract for Navy DT's, he had specialized on military planes, of which he had built almost a thousand. Then in July, 1932, the second depression struck the aviation industry and for four months 577 shop employees had no planes to build. In these circumstances, Douglas decided, against the advice of his engineers, to design a plane which would meet the seemingly impossible specifications posed by T.W.A.

These specifications demanded a plane that could, on a single engine, out-perform the Ford trimotor on two engines. Specifically, they required that one motor be cut after completing half the take-off run on any T.W.A. field, that the plane then climb to 1,000 ft. before dumping any gas, and thereafter it should fly to the next T.W.A. airport, at the same time retaining the excess 35 per cent of fuel required by Department of Commerce rules.

There was also required a top speed of 183 m.p.h., a cruising speed at 75 per cent throttle of 162 m.p.h., an absolute ceiling of 24,800 ft. and a landing speed of 64 m.p.h.

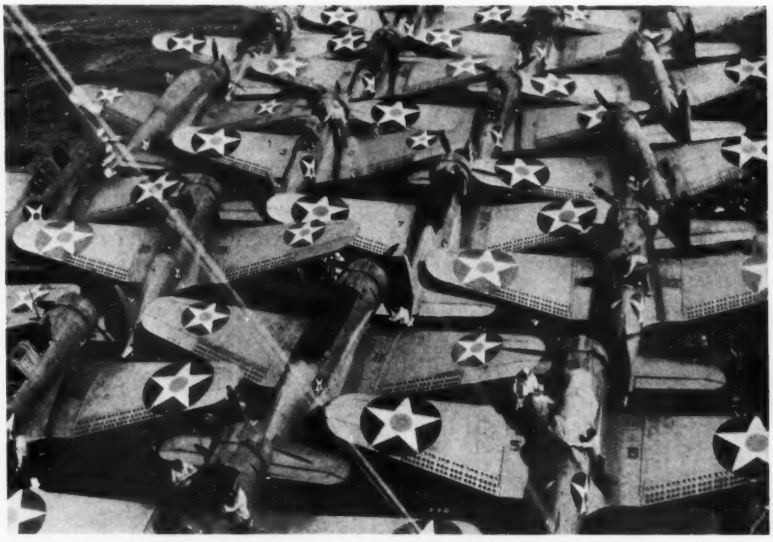
Douglas said it could be done by taking advantage of all advances in aeronautical sciences; he had a design drawn up in five days.

The resulting plane not only took off on one motor from the *highest* T.W.A. airport, but bettered specifications by 30 m.p.h. on top speed, 29 m.p.h. on cruising speed, 600 ft. in altitude and six miles in landing speed.

In addition to increasing speed and safety, it contained factors looking toward the comfort of passengers. Not only was vibration reduced to a minimum but the interior of the cabin, thanks to the cooperation of the best acoustics engineers, was slightly less noisy than a Pullman car.

Air lines, domestic and foreign, immediately commenced placing orders for the new DC transport; and Douglas' personnel had to be quadrupled within several months.

While there was no evidence of a letup in the demand, and 138 of the planes were delivered in the next three years, Douglas almost immediately started designs for the bigger and improved version that was to be known as the DC-3, or Douglas Transport Sleeper.



Official Navy Photograph

Douglas SBD's (except two planes in far center).

The new 21-passenger day plane made its appearance in 1936, and almost 600 were constructed in the next five years.

Together, the DC-2's and DC-3's were standard equipment on 95 per cent of the major air lines of the United States, and were serving on 22 foreign lines flying over 57 countries before the war.

When, following our entry into the war, the Army took over plane production, it found an established source of supply in the assembly lines of Douglas DC-3's. It also found the huge four-motored 52,000-lb. C-54 flying boxcar engineered, tooled and in production.

At the same time that Douglas had started designing the DC-3, he had ordered blueprints on three military planes that were to play an important role in our war effort.

These were the Navy's SBD dive bombers and TBD torpedo planes, and the Army's DB-7 light bombers, which are today known in the R.A.F. as Bostons and as Havocs (A-20) in our own Air Force. All three of these military planes were in production when the conflict broke.

Flying at 350 m.p.h. plus at too low a level to be vulnerable to either anti-aircraft fire or interceptor attack, DB-7's have been credited with driving German airports some 40 km. back from the Channel, thus giving R.A.F. fighters time to meet bomber attacks.

In Lybia they comprised what the British troops called the "Boston" Shuttle Service, an endless relay of strafing bombers that were fueled and supplied by rear guard transports and which struck ceaselessly at Rommel's spearhead.

The SBD's and TBD's are probably Douglas' most vital contributions to the country, if not to aviation. These planes not only existed in quantities to arm our Navy's Pacific carriers when we entered the war but our pilots were thoroughly skilled in the handling of them.

The result was our victories at Salamaua, Lae, Tulagi, the Coral Sea and Midway, where they comprised a major part of our carrier-based attacking force. In addition, they participated in our naval attacks against the Marshalls and Gilberts.

They have been credited by the Navy with sinking more than 25 Japanese naval vessels and seriously damaging an equal number. Among their victims were five Jap carriers, which they either sank outright or put out of action so that they became the defenseless victims for high-level attack.

These planes are also being used by the Marines at Guadalcanal and, since our occupation of that strategic island, they have been credited with the sinking or damaging of enemy cruisers and destroyers.

Simultaneously, Army dispatches have told of heavy A-20 attacks against Japanese supply lines in New Guinea.

Douglas' program of the past decade has been not only better planes in every category but a supply of these planes when and where they were needed.

Melmac's Unique Electrical Properties Give New Insulation Performance

MELMAC* is serving the country's toughest wartime needs for an insulating material of high dielectric strength and high arc resistance that *must not fail;* that knows no fatigue; that will withstand any condition of service from extremes of arctic cold to torrid tropic heat; that will withstand the arcing tendency of rarified atmosphere or humidity at the dew-point.

TYPICAL APPLICATIONS: Ignition assemblies, insulation parts, shields, switch plates and boxes, relays, circuit breakers, controls.

TYPICAL SPECIFICATIONS:
Melmac *P-592* (Mineral filled)
Dielectric Strength 445 Volts/mil.
Arc resistance (ASTM) average—135 seconds

Melmac, the melamine-formaldehyde thermosetting plastic developed by Cyanamid, is continually finding new uses, continually being adapted or modified to meet new and specialized requirements.

Write for further information. Data sheets are available. A Priority Rating is currently required for commercial use of Melmac. Samples can be supplied without priority for research and testing purposes.

AMERICAN CYANAMID COMPANY
PLASTICS DIVISION
36 ROCKEFELLER PLAZA, NEW YORK, N. Y.

*Reg. U. S. Pat. Off.

Melmac A CYANAMID PLASTIC

Fairchild Contributes to Aviation Progress

CHARLES H. GALE*

Sherman M. Fairchild, Chairman of the Board.

As with most aviation manufacturers, Fairchild Engine and Airplane Corporation has been able to achieve many developments in its products in the last ten years. Looking back, it is gratifying that so many of these development efforts have borne fruit, particularly in that they have matured in time to play increasingly effective roles in the war effort. The Fairchild development policy, carried out in such a way that the term "Visioneering" has been applied to it as contrasted with run-of-mine engineering operations, has been maintained throughout our history, even when aviation as a whole was a struggling industry.

Fairchild research has made available such products as the widely used PT-19 Army primary trainer with a wing that embodies unique stability characteristics; Ranger air-cooled engines that combine the advantages of air-cooling with those of the in-line, inverted arrangement of cylinders; and the Duramold process of utilizing plastic-bonded plywood in the manufacture of many military products out of non-strategic materials, including the first molded plywood, twin-engined combat crew trainer for the Army.

The oldest unit of the corporation, Fairchild Aircraft Division, has always concentrated on the development of rugged and stable aircraft having a high operating efficiency. One of its most famous designs that came into its own in the middle 1930's was the single-engined, high-wing, F-24 cabin monoplane. Constant refinements of this model made it a leader in the private and business plane field before the war and, more recently, has won an important war job as an "aerial staff car" in the United Nations' air forces.

Out of the F-24 stemmed the now famous PT-19 military primary trainer. The same engineering and construction characteristics of the 24 were incorporated in the PT-19 when the Army requested the development of a trainer meeting its specifications that could be turned out in volume to keep pace with expanding training needs. This airplane, known as the Cornell, is used with slight modifications in the British Empire Training Plan. The outstanding single feature of this two-place, open cockpit, low-wing monoplane is a wing so designed that it combines the efficiency of a tapered wing with wing tips that do not prematurely stall. Because of the excellent handling characteristics of this airplane, it has been ordered in large numbers for Army fledglings.

Development in the middle 1930's of the Fairchild amphibian and cargo plane, each powered by a single engine, demonstrated to the company the great need for the development of both materials and processes that were simpler and faster than conventional ways and means of aircraft manufacture, especially anything that would eliminate the use of many thousands of rivets per airplane.

Research resulted in the development of the Duramold molded plywood process. The initial experimental work, directed by Col. V. E. Clark, resulted in the building of the C-46 low-wing cabin monoplane, the monocoque cabin of which was made by this process as then developed. Years of operating experience with the C-46 and further extensive research made it possible in recent months for Fairchild Aircraft Division to produce by the Duramold process the twin-engined AT-13 and AT-14 combat crew trainers (Wasp and Ranger powered, respectively). The former, which has been flying for several months, is the first multiengined military airplane produced by any molded plywood process.

In view of the pressing need to be as independent as possible of strategic materials, the use of such a process obviously is in a position to smash bottlenecks in the fabrication of much critically needed military equipment. The process is, of course, applicable to other than complete aircraft; it already has been applied to a wide variety of parts.

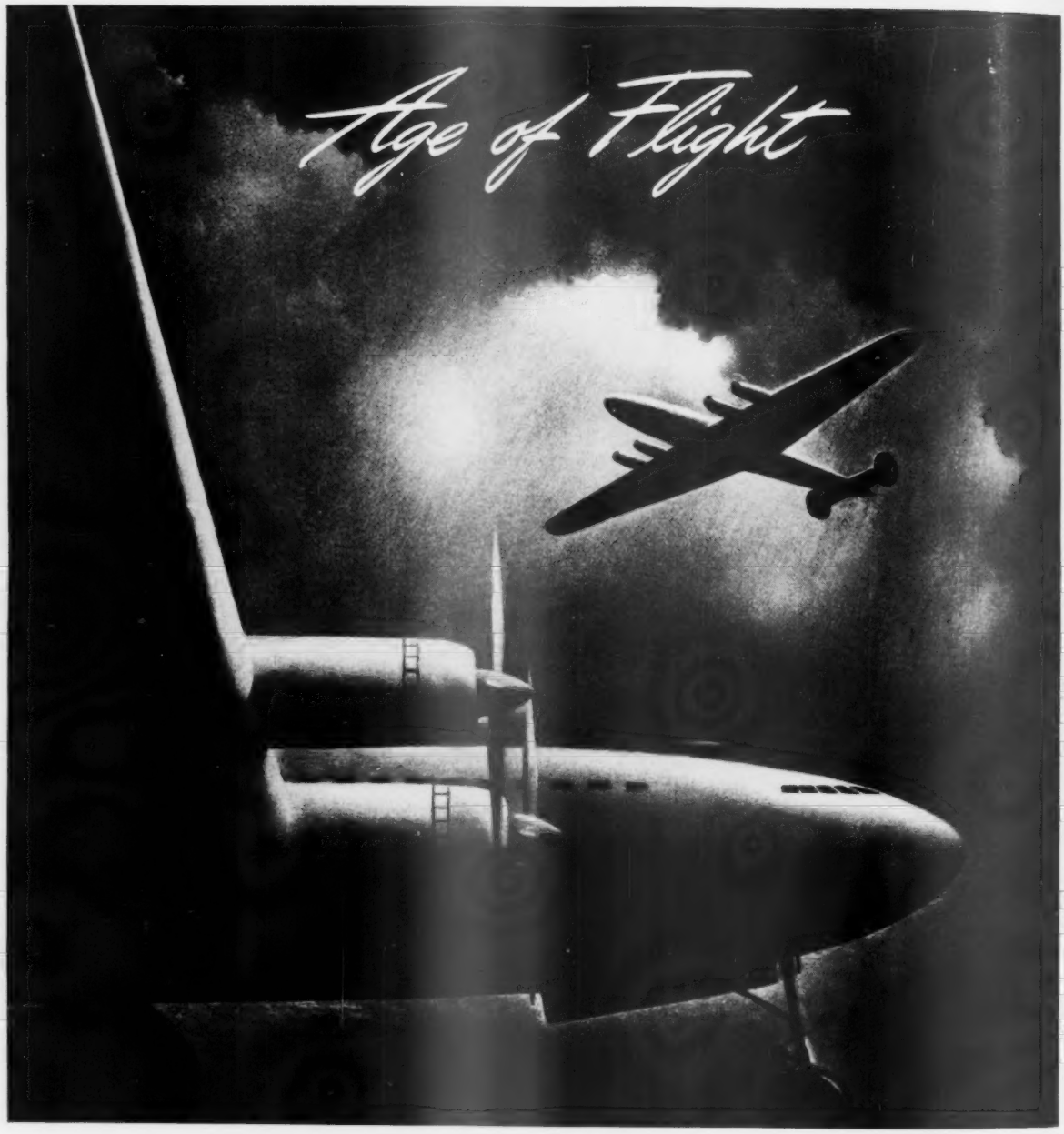
In the eternal war against drag, the Ranger Engines Division has pioneered alone along most important lines. It has combined the advantages of air cooling (reduced weight, simplified design and lowered vulnerability by virtue of the absence of liquid-cooling system) with the advantages of a low frontal resistance obtainable by the in-line arrangement of cylinders. For the sake of increased visibility for the pilot and for easier maintenance, it has inverted cylinders and was the first to provide automatic lubrication of the valve system.

The Wasp-powered Fairchild AT-13 combat crew trainer produced by the Duramold process at Hagerstown, Md.

Starting with the six-cylinder units, which established high performance records in hundreds of private aircraft and later in the PT-19's, Ranger has developed the twelve-cylinder model to the stage where it is now standard equipment in a new type of fast Navy Scout Observation plane and is being adopted in other military aircraft.

Naturally it has been possible here to mention only a few high spots in our progress in the past decade. For military reasons late developments cannot be discussed now. Fairchild will continue its research and development mark for peace as well as war applications.

* Fairchild Engine & Airplane Corp.



IN THE FREE TOMORROW FOR WHICH WE FIGHT

In the sky, now, are the fighter planes, trainers and bombers, the transport planes that crisscross continents and hemispheres.

What is their business aloft?

To defeat an enemy. To build the structure for a better world.... Even now, looking skyward, you can see the magic Age of Flight!

• • •

The airplane has altered forever our concept of time and distance. Giant United Mainliners speed with military men and goods and civilian passengers from California to New York overnight. Tomorrow, in the Age of Flight, you will go from California to London in less than a day.

There will be no barriers of sea or desert in the air-borne world of tomorrow. You will transact ordinary business with customers throughout the nation and the world.

Does this still appear a vision to you? Hundreds of big United States flying ships now cross the seas weekly. Sky locomotives are pulling gliders packed with war goods. Airports have sprung up where neither highway nor railroad could penetrate in the past.

United Air Lines now draws upon 17 years of air transport operation to hasten the winning of the war. That vast fund of experience, plus the years of the war effort, will serve the nation in the Age of Flight.

★ BUY WAR BONDS FOR VICTORY

UNITED AIR LINES

THE MAIN LINE AIRWAY

Fleetwings, Inc.

FRANK DE GANAHL*

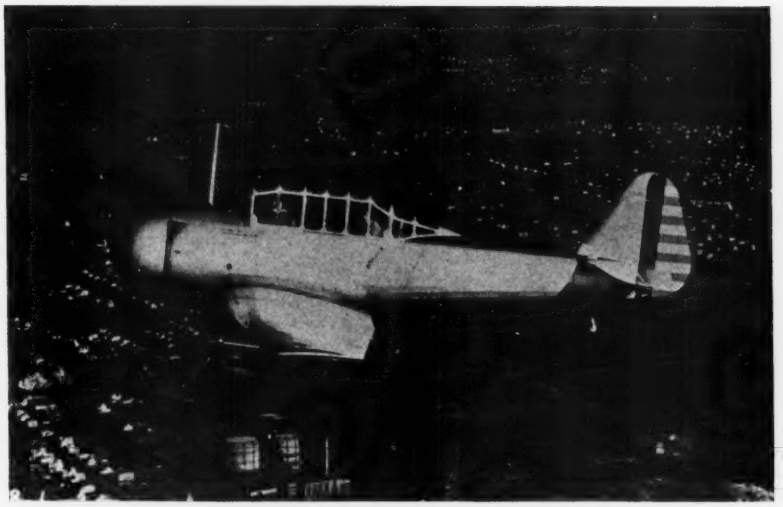
THE HISTORY OF AVIATION will show that Fleetwings and the use of stainless steel in aircraft both got started about the same time. Fleetwings was organized in 1928, commencing operations at Roosevelt Field, for the purpose of developing spot welding for aircraft. Soon after the beginning of this work, it was realized that stainless steel had properties that not only lent themselves readily to successful spot welding but also made stainless steel highly desirable for aircraft.

After much experimentation and research Fleetwings constructed the first stainless-steel wing that ever flew. And now Fleetwings' men and women are working on production of the BT-12, the first military craft ever built principally of stainless steel.

The first amphibian in stainless steel—the Seabird, a four-place plane, since followed by others that have proved their worth in all climes from the Arctic to the Tropics and are continuing to give evidence of their ruggedness due to absence of corrosion and ease of maintenance—was conceived and designed by Fleetwings.

One of the reasons that stainless steel did not come into general use more quickly than it has is because a new concept was required and new principles of design had to be developed. Fleetwings went to work developing those principles, ultimately putting them into use in quantity production. Today Fleetwings is the largest manufacturer of stainless-steel structural aircraft and aircraft parts in the world.

When the war began, Fleetwings turned its attention to helping in the National Program, devoting all its efforts to that end. Its resources, experience, and facilities indicated that it could contribute most effectively and rapidly by taking on subcontracting for the larger aircraft producers, thus enabling them to increase materially their output of completed planes. The manufacture and, in many cases, the design of such parts as rudders, elevators, wings, ailerons, stabilizers, flaps, etc., were turned over to Fleetwings by several of the principal prime contractors of the country.



Fleetwings Basic Trainer, BT-12.

Recent Progress

Evidences of the plant's growth since the start of the Emergency are abundant. Additional building space for production has been marshaled, to be sure but the most significant strides are seen in the scores of innovations made within the plant itself. The new streamlined production system with its series of long, straight-line-flow assembly lines heads the list. More than a dozen "fluorescent tunnels" that house the final assembly lines appear like long, brilliantly clean arms reaching through various parts of the plant.

The large-scale installation of arc-welding equipment to supplement spot-welding and further speed production is another sign of Fleetwings' progress as are the inventions by Fleetwings' specialists of a great number of small, ingenious tools such as rivet punches and rivet cutters that do ten times the work previous tools did; conveyor lines that speed the application of primer paint coats on all aluminum-alloy surfaces, and a chemical process for cleaning Alclad for production spot welding.

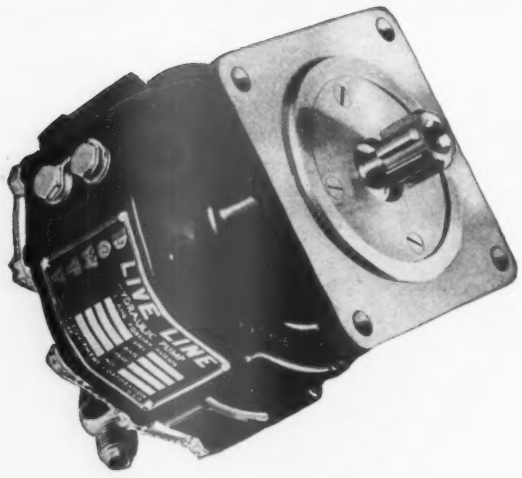
Fleetwings has developed stainless-steel spot-welding machines that can weld corrugated material to flat sheet and closed stringers to flat sheets at a rate of 960 spots per minute. Such speed in fastening materials together is difficult, if not altogether impossible, by any other means of fabrication. Even single spot welds when done on fittings, etc., are a much faster and easier operation than riveting. Lap joints can be made to attain the full 100 per cent tensile strength of the sheet itself, whereas in riveted or other type joints this is impossible. Where fittings are required for heavy loads they can be made much smaller when spot-welded since the spots can be placed at much closer pitch than rivets, and no strength is lost due to rivet holes reducing the net area.

Personnel Trained

To assure a steady stream of trained hands for the expanding factory, Fleetwings opened about two years ago, in cooperation with the National Defense Vocational Program, a school for grooming novices in sheet metal work. Only the basic principles of welding, riveting, blueprint reading and the other allied trades are studied. No attempt is made to crowd the course with details. This school provides a constant source of suitable personnel for the various shop departments. Other training courses for foremen, leaders and supervisors have also been established with considerable success.

Using the past as a guide to the future, we are optimistic about what can be accomplished in the months and years that lie ahead. Because Fleetwings is not one of the big companies it is expected that when the current emergency is over the reduction in forces will not be so great percentage-wise as in other organizations. And it is hoped that trained personnel will be able to make the most of a well-rounded experience in all departments—design, engineering, production—with all types of flying machines—wood, aluminum alloy and stainless steel.

* President.



DOWTY *Live-Line* PUMPS

From an original British design, Dowty *Live-Line* Pumps were developed for production by American engineers. All units offered for sale in the U.S.A. are manufactured here of American materials, and are serviced directly from our plants in this country.

A. E. Ulmann

President

DOWTY

EQUIPMENT CORPORATION

LONG ISLAND CITY • NEW YORK

SPECIALISTS IN LANDING GEAR & HYDRAULIC EQUIPMENT FOR AIRCRAFT

The Goodyear Tire and Rubber Company

PAUL W. LITCHFIELD*

STARTING WITH free balloons shortly after the turn of the century, Goodyear has pioneered most of the work on lighter-than-air craft in this country. This long-time research and development program on airships has resulted in the contribution of many ideas and suggestions for the present advancement of heavier-than-air craft. Many of these contributions have found a permanent place in the existing aircraft program and are being widely used not only by Goodyear but by many of the leading aircraft companies.

METALLURGICAL DEVELOPMENTS

Goodyear, as airship builders, was in a large degree responsible for the early development of many high-strength materials. It was the first aircraft manufacturer to construct frameworks using the 17S-T aluminum alloy. In cooperation with the U.S. Navy and the Aluminum Company of America, a series of experiments were conducted along the lines of strain-hardening with the result that an improved material was produced that was identified as 17SRT.

Further work with the U.S. Navy and the Aluminum Company of America resulted in the development of an aluminum alloy by the Aluminum Company of America (24S) which had higher strength characteristics and better resistance to fatigue.

In anticipation of the day when larger and stronger structures would be needed, Goodyear engineers have developed a variety of artificially aged stainless steels having extremely high strength properties. In addition, a low melting point austenitic welding rod was produced for joining high- and low-strength steels.

MANUFACTURING AND PROCESSING

Goodyear's contributions toward an important phase of aircraft manufacturing—processing—also began during the construction of the large airships. Various processes were developed which added greatly to the knowledge of forming, working, fabricating, and heat-treating of aluminum alloys, and many procedures were established about which no technical information was previously available. A recent contribution to the art of forming aircraft parts is an inexpensive draw die used in conjunction with the hydraulic rubber platen press. The use of this die decreases production time and costs and produces extremely accurate parts. The method of spot welding aluminum Alclad alloys, which is now being universally used in the aircraft industry, is a Goodyear invention.

STRUCTURAL DEVELOPMENTS

Among the contributions in the general field of aeronautical science are new theories for treating space frameworks as related to elasticity and elastic stability. Structural models of full scale prototype structures have been built to check these new theories, and the results have been satisfactory.

Perhaps in no other type of structure had it been so necessary to know and understand the causes of fatigue failures as those encountered in the earlier airships. This ultimately led to the development of special fatigue testing equipment. Because of its related influences, some of the earliest work on the effect of atmospheric gusts on aircraft, in both magnitude and frequency, was premised by Goodyear engineers. A considerable number of scientific instruments were also developed, including stress change recorders, maximum stress indicators, absolute reading strain gauges, and yield point recorders.

FABRIC STRUCTURES

From the early rubberized "staytight" fabric, which Goodyear contributed toward a more efficient wing covering, evolved the modern nonrigid envelope structure. This multilayer impregnated fabric combines the properties of effectively absorbing the stresses encountered by the airship itself with that of confining the lifting gas.

With this background in fabric structures, it was possible to design and build various sizes and types of barrage balloons for the services. Another outgrowth of this knowledge was the design and construction of envelopes for stratosphere balloons.

Early work in rubberized crashproof fuel tanks contributed to the development of the present highly efficient bullet-sealing tanks.

Many new products have become possible which in the present war are saving much valuable life and equipment. Among these may be included flotation gears for crippled airplanes, pontoons for seaplanes, life rafts, mark buoys, life saving vests, salvage gear and many other items dependent upon a lightweight high-strength water displacing unit.

With Goodyear's place in the rubber field, it was natural for it to pioneer the development of the various rubber products in keeping with the other advances in aviation. This has resulted in many contributions, among which may be included the low-pressure airplane tire and dual seal tube which have aided so greatly in increasing the safety of air travel and prolonging the life of the airplane. The rubber motor suspension isolates the motor vibration transmitted to the main structure, lengthens the service life of the airplane and adds to the comfort and efficiency of the operators and passengers. Various synthetic rubber items made of Goodyear's "Chemi-gum" have the double advantage of not only being resistant to most fuels, oils, and gases but also of remaining pliant and flexible at sub-zero temperatures.

Goodyear, long an exponent of the use of airships in this country, is now building long-range, nonrigid airships for military purposes. These airships are far superior to those of prewar days in range and performance.

RESEARCH

It is our belief that as an aircraft carrier, the large rigid airship would become indispensable for quickly and efficiently carrying our fighter planes to distant combat zones. We are continuing fundamental aerodynamic and structural research in the field of lighter-than-air in anticipation of the time when large airships will be constructed to fulfill their part in the present war or to meet the need for long-range cargo carriers.

It has always been Goodyear's conviction that aircraft, both lighter- and heavier-than-air, are destined to rank in importance with other forms of transportation. For the time being, the emphasis is on aircraft for war purposes and, in keeping with our national responsibility, we have not only maintained our position as America's leading producer of lighter-than-air craft but have also embarked on a program for the manufacture of complete airplanes. Believing in this form of transportation, the American system of free enterprise, and the future of our country, we will continue in our endeavor to advance all phases of aeronautics through intensive efforts in the fields of research, development and production.

* Chairman of the Board.

Day after tomorrow may be too late

A huge four-engine flying boat lifts itself from the sea and roars out over the embattled Atlantic . . . here today, Europe tomorrow . . . and the men who fly it are helping to fight this war.

For some messages must be delivered face to face. The ability of some one in Washington—*today*—to meet some one in London—*tomorrow*—is a vital necessity.

Those who pilot overseas transport planes are fighting shoulder to shoulder with the heroic men of the Merchant Marine in the great battle of transportation—the battle that must be won in order that the United Nations can win the war.

With new long-range flying boats setting new records for Atlantic crossings, men of American Export Airlines are helping to cut down the distance between America and her fighting allies.

With new fast cargo ships plying the sea lanes, men of American Export Lines are helping to speed the flow of war matériel to the fighting fronts of freedom.

American Export *Lines Airlines*

25 BROADWAY, NEW YORK

A Decade of Grumman Amphibians

F. J. KURT*

TEN YEARS AGO the Grumman Aircraft Engineering Corporation was a small company growing steadily in spite of the severe depression in the aircraft industry at that time. Work was progressing on the first of a long and still continuing line of fighters for the U.S. Navy. This model, the Navy shipboard fighter FF-1, was outstanding as the first fighter with retractable landing gear. The success of this design led to increased orders from the Navy and to the development of the F2F, first Grumman single-seater fighter.

The next progressive step in fighter design was the F3F, another single-seater carrier-based fighter. With the appearance of this airplane, the difference between carrier-based and land-based aircraft disappeared. The F3F was the equal of the best contemporary land-based planes.

The latest fighter development and the present standard fighter of the U.S. Navy is the F4F Wildcat. The Wildcat has established spectacular victories over Japanese aircraft in the Pacific. Lt. Commander Edward O'Hare flew a Wildcat when he shot down five Japanese bombers in one engagement—a rare performance. Another famous Wildcat pilot is Major John Smith of the U.S. Marine Corps, who at the present time has shot down more planes than any other American flyer. In one engagement he destroyed four Japanese Zero planes in less than 15 min.

An interesting phase of Grumman development and a major part of their contribution to the aircraft industry is the amphibian production. Beginning in 1933 and extending through the present time, Grumman has probably been the largest producer of amphibians in the world. The start of the line was the JF-1, designed for carrier and catapult use. The JF series has enjoyed one of the longest design runs in history, the latest modification having been produced in 1942. A utility biplane amphibian, the JF was equipped with a machine gun and bomb racks as well as provisions for aerial photography. The U.S. Navy, Coast Guard and Marine Corps employed this model as an all-purpose airplane, and it earned a reputation as an excellent rough water plane. In Coast Guard tests it established amphibian altitude and speed records.

Entering the commercial field in 1937 for the first time, Grumman produced the G-21. The G-21 is a high-performance, twin-engined amphibian. Seating eight, it was originally intended for the private owner and commercial market. Successful use of the airplane by oil and air transport companies in remote regions inaccessible to land planes attracted the attention of the U.S. Army, Navy, and Coast Guard, and orders were placed by each of them.

Grumman Widgeon, a four-to-five-place utility amphibian.

Versatility is perhaps the outstanding feature of the G-21 design. It performs diversified tasks in widely scattered bases all over the world. Guns are mounted on it for military service and the U.S. Coast Guard has installed depth charges for submarine defense in this country. In the Dutch East Indies and New Guinea it is a light transport; in Alaska skis replace the conventional landing gear. It negotiates landings and take-offs on the narrow bayous of the Louisiana oil fields and patrols the coasts of South America and Africa. Piloted by a U.S. Army Air Corps flier, it established and still retains an amphibian speed record over a 1,000 km. course.

The Grumman Widgeon is the latest amphibian design developed by the corporation. A twin-engined four-to-five-place monoplane powered by Ranger engines, the Widgeon gross weight is slightly less than half the G-21. Like the G-21, it was originally designed for the private and commercial market. The U.S. Coast Guard placed the first military order for the Widgeon, which they designated the J4F-1. Also like the G-21, it has proved highly adaptable as an all-purpose utility amphibian.

In the Coast Guard the Widgeon was first assigned to in-shore patrol. This assignment required the ability to operate from small bodies of water and perform well regardless of weather conditions. With the entry of this country into the war, the Widgeon was fitted with a large aircraft type depth charge and assigned to off-shore patrol and convoy duty. At a low throttle setting the Widgeon has exceptionally long endurance—an asset particularly valuable for convoy work.

An inherent feature of the Widgeon design is its safety. The all-metal riveted-construction hull is an excellent safety feature for ground landings under conditions that render landplanes impossible or disastrous to bring down. Wheels-up landings have been made with no more damage than scratching of the bottom paint or the scraping of the easily replaced keel section.

The latest releasable Grumman development in combat aircraft is the Avenger. The Avenger is the Navy's most modern torpedo bomber and has taken a heavy toll of Japanese shipping. It played an outstanding part in the recent Navy successes in the Pacific and is the deadliest aerial weapon to appear against enemy navies.

New ideas and designs are being developed at Grumman. Restrictions prohibit their publication, but experience and knowledge obtained from building U.S. Navy combat aircraft and amphibians are being employed to turn out increasingly more effective aircraft for today's war and tomorrow's peace.

* Grumman Aircraft Engineering Corporation.

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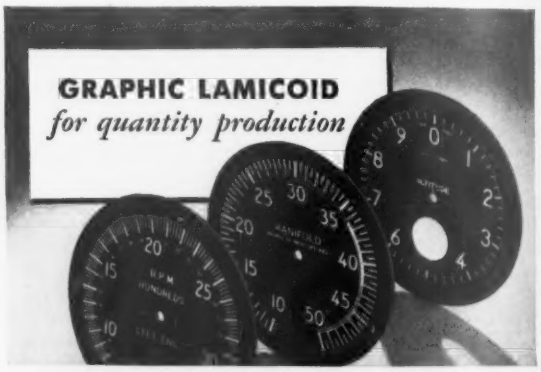

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Kellett Autogiro Corporation

R. H. PREWITT*

DURING THE PAST DECADE the Kellett Autogiro Corporation, pioneers in the development of rotating wing aircraft, have designed and built a dozen different autogiro models, including both the earlier fixed-wing type incorporating surface controls and since 1934 the more recent wingless types incorporating direct control.

A fixed-wing Model K-3 Autogiro, operated by Pilot William S. McCormick, accompanied Admiral Byrd on his second antarctic expedition in 1934. Early in the spring, on a day when the temperature registered −61°F., this autogiro initiated its daily (weather permitting) flights, recording upper air weather observations. These flights were made successfully for a month. Once in the fall, two airplane fliers went off their course in bad weather and made a forced landing. With the aid of the autogiro, Admiral Byrd and McCormick located the grounded fliers miles from where they were expected to be. The autogiro proved to be extremely helpful because of its ability to land in many places where none of the airplanes could operate. Other autogiros of this type were extensively used in the United States and were the first rotating wing aircraft to appear in Brazil and the Argentine.

On May 25, 1935, Kellett Model KD-1 Autogiro, the first wingless type produced by Kellett, piloted by Lou Leavitt, delivered the first air mail to the Philadelphia Post Office roof. On April 28, 1936, Pilot Leavitt landed KD-1 Autogiro at the Capitol steps in Washington, D. C., for inspection by members of the Senate Commerce Committee on "Safety in the Air."

In 1935 a contract was negotiated with the Army Air Corps for a Model YG-1 Direct Control Autogiro. Later the Air Corps purchased a Model YG-1A and, subsequently, seven Model YG-1B Autogiros, which were used for training pilots and mechanics in the first Army Autogiro School, conducted by Lt. H. F. Gregory at Paterson Field, Fairfield, O. The seven YG-1B Autogiros went through extensive service tests at the conclusion of the training period.

On January 17, 1939, Eastern Air Lines obtained a contract from the U.S. Post Office Department in Washington for conducting an experimental autogiro mail shuttle service between the Philadelphia Post Office roof and the Camden Airport. The Kellett Autogiro Corporation designed and built a special direct control wingless Model KD-1B Autogiro for this purpose. This machine has a one-place enclosed cockpit in the rear and a forward mail compartment taking the space normally occupied by a passenger. The machine was successfully operated by the Eastern Air Lines for one year between July 6, 1939, and July 5, 1940. This machine gave excellent service, especially in view of the turbulent conditions encountered on the roof with adverse winds. The high-wind operating conditions were made more severe because of the construction of the roof. The landing area was located in a pocket bounded by 4-ft. ramps on the north and south sides, and by 15-ft. penthouses extending the full length of the building along the east and west sides. Under certain wind conditions the air was extremely turbulent in and above the landing area.

Less than 0.5 per cent of trips were canceled because of mechanical difficulties.†

In addition to the air mail and military tests carried out with these giros by the Artillery, Cavalry, Infantry and other branches of the ground troops, Kellett autogiros of the YG-1 or KD-1 type have also been used or tested by many other branches of Government. Among the purposes for which these autogiros have been used are coast patrol and rescue work for the U.S. Coast Guard and for the U.S. Bureau of Biological Survey, border patrol by the U.S. Bureau of Immigration, scouting patrol and observation by the U.S. Department of Justice, and forest patrol by the U.S. Forest Service.

On several occasions Model KD-1 Autogiro was successfully used by the Police Department in directing traffic through a two-way radio system to and from the Army-Navy Football Games held at the Municipal Stadium in Philadelphia.

As a result of Kellett's long and active development of rotating wing aircraft, they have established many "firsts" in this field, as listed below:

1. First side by side autogiro.
2. First Department of Commerce approved direct control autogiro.
3. First rotating wing aircraft in the world to land on the roof of a building.
4. First rotating wing aircraft in the world to land on and take off from a post office roof (Philadelphia and Chicago).
5. First and only rotating wing aircraft to be operated in the antarctic.
6. The first rotating wing aircraft to be service tested by the Army Air Corps.
7. The first rotating wing aircraft to be service tested in airmail shuttle service.

During the past ten years members of the Engineering Department of the Kellett Corporation have presented seven papers dealing with widely varying aspects of rotating wing aircraft design at meetings of the Institute of Aeronautical Sciences. They have also contributed many advanced design features toward the physical development of rotating wing aircraft. Some of the most important developments are listed below:

1. Extensive studies, tests and mathematical investigations into vibrations and resonance in rotating wing aircraft.
2. Improved mass-balanced rotor blades incorporating airfoil section having zero moment coefficient.
3. Initial theoretic work on jump take-off, including improved methods of blade pitch control.
4. Mechanically damped centering of blades eliminating 1 to 1 ground resonance.
5. Epicyclic rotor drive system incorporating additional feature of automatic release with excessive load.
6. Frictionless blade pitch control providing high blade torsional frequency.

In addition to this work in the rotating wing field, the Kellett Autogiro Corporation has been active in subcontract work for prime aircraft manufacturers since 1937. Products built include control surfaces, seats, engine mounts and other welded structures.

* Vice-President and Chief Engineer.

† Cancellations because of weather are misleading in that minimum operation requirements were 2,000 ft. ceiling and 5 miles visibility during the first six months of operation. Later these restrictions were changed to 1 mile visibility and 1,000 ft. ceiling. No flights were made on instruments, although the ship was equipped with blind flying instruments that could have been used in an emergency.

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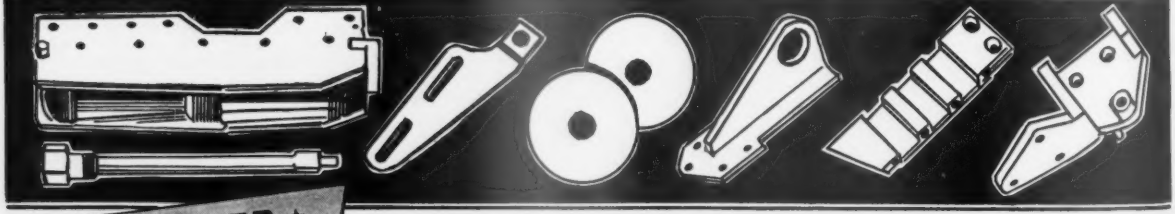
★ ★ ★ Clearly, by planning now to use the facilities of Spriesch modern war production ability, you will be a step ahead of your competitors. A step that may change your future to leader in your field! Joseph J. Cheney, President.



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Ten Years of Lockheed Engineering

HALL L. HIBBARD*

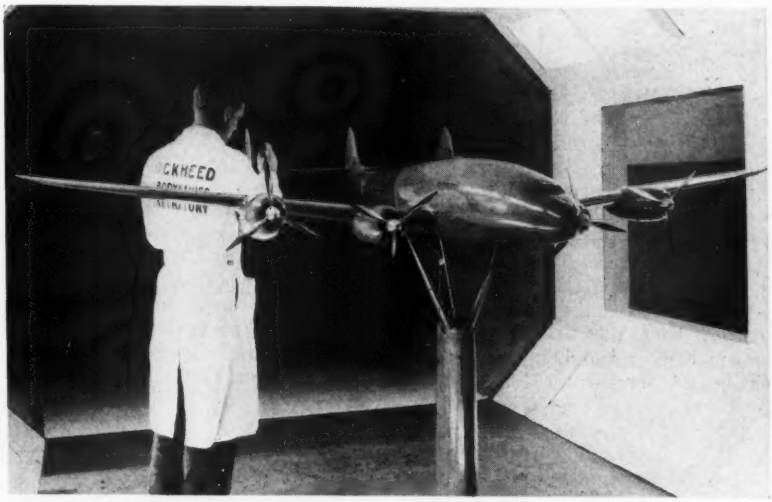
A TEN-YEAR HISTORY of Lockheed's engineering contributions to aviation coincides almost precisely with the life history of the Lockheed Aircraft Corporation under its present ownership. The company now headed by Robert E. Gross was formed in 1932 and built ten aircraft in its first year, some of which still are flying. Their unique monocoque plywood construction, inherited from Alan and Malcolm Loughead, was the first of Lockheed's long list of "firsts," and it is interesting to note that it is returning to favor today.

These plywood Lockheeds—the Vega, Sirius, and Altair—piled up an impressive record of "first and fastest" flights across several ocean routes and continents. They were first to fly both poles, first to solo around the world, first to be flown by a woman across the Atlantic and the Pacific alike, and they set a chain of transcontinental speed records which came to a climax in 1940 when a Lodestar cut the first Lockheed record in half.

Since the change in ownership and the trend toward metal began ten years ago, every effort has been made to maintain this Lockheed tradition of Leadership. The conference method of engineering was promptly adopted, and every Lockheed model since then has been the product of the merged effort of the engineering department, small or large. This deliberate system has been a factor in making every Lockheed model the fastest transport of its time—a distinction that will be maintained in the forthcoming Constellation. The Constellation will be the largest of all cargo landplanes.

Beginning with the Vega in wooden ships and the Electra in metal, Lockheed has been first in production with many features that have been widely adopted in the industry. The Electra itself was one of the early bimotored metal transports and the first modern plane to use the twin-tail construction, which is now all but standard on multimotored aircraft. The Orion was the first commercial ship to use the retractable landing gear, reducing the drag by as much as 60 per cent in some planes today.

Pioneering of the single-spar all-metal wing was another Lockheed privilege, allied somewhat with the perfection and first use of the Fowler flap for reduction of landing speed to a safe level without loss of flying speed. Thus



Model of Constellation in Lockheed wind tunnel.

began the Lockheed pioneering of heavy and heavier wing loading for the sake of greater speed and higher efficiency with safety.

From this basic development of an effective transport ship came the quick redesign which is the Hudson bomber, first American plane to go into mass production for this war and, of course, the first to fight over Europe. The Hudson is a military version of the Lockheed Model 14, just as the Vega Ventura is an adaptation of the larger and later Lodestar transport.

Groping into the stratosphere began with the XC-35, first successful fully pressurized "stratosphere ship," which opened up a new list of problems. At the same time there was much pioneering in the research on "supercharging" the pilot, which was undertaken with the collaboration of the Mayo Clinic.

The P-38 has a number of innovations to its credit, being still rated as one of the world's fastest and highest performing military airplanes. It was the first American ship to exceed 400 m.p.h., the first American bimotored fighter, and one of the first exhaust turbosupercharged fighters to be put into production. Some additional innovations in design and performance remain on the Army secret list.

In the production and factory engineering fields, Lockheed met the requirements for almost instantaneous expansion in a new way. A high-speed training program was launched in collaboration with an accredited engineering college, and engineers from many specialized branches were quickly orientated in aviation. This "change-over" program produced hundreds of capable aviation engineers in time to meet the demand.

At about the same time Lockheed was completing the first large-sized, high-speed wind tunnel owned by private enterprise, which contains many innovations in design. Production for war was adding new pressure, and the perfection of the X-ray testing of production parts was one answer. Perfection of the phototemplate process, an electrolytic transfer by which work templates can be reproduced in 5 min., was another.

A third was the pioneering of plastic tooling in production, so that three-dimensional contours may be "poured," hardening into tools that will support drop-hammer impacts or 8,000 lbs. per sq. in. under the hydropress. Many production short-cuts have been put into effect to meet the emergency and have been made available to other aircraft builders under the present pooling plan for the national welfare.

These measures have enabled Lockheed to keep pace with the tempo of emergency production, until the aircraft output for July of 1942 alone exceeded that for the entire year of 1940. The engineering staff today exceeds by many times the total personnel of Lockheed ten years ago; the quality of the aircraft they produce has increased along with quantity, and those are some high lights of the engineering history of Lockheed's first ten years.

* Vice-President and Chief Engineer, Lockheed Aircraft Corporation.

The Glenn L. Martin Company

WILLIAM K. EBEL*

THE PAST DECADE has been one of tremendous accomplishment in American aircraft design and manufacture. In this accomplishment, now so important to the preservation of civilization, The Glenn L. Martin Company engineers are proud to have had a part.

Our own particular share in what has been accomplished in the past ten years began with the winning by Glenn L. Martin of the Collier Trophy for 1932. It was in that year that Martin engineers introduced the famous B-10 bomber. Up to that time the standard air-arm bomber had been the B-6, a wire-braced, fabric-covered biplane of wood and steel tubing. The B-10, a skin-stressed cantilever monoplane built entirely of aluminum alloy, supplanted the B-6 and may be said to be the prototype of all bombers built since. Though itself obsolete now, in its day it flew a hundred miles faster than any other bomber of its time and equalled or excelled the speeds of the fastest pursuit planes then in use.

Martin engineering's next great accomplishment was the famous China Clipper and her sisters. They were in their time the largest flying boats ever to soar over water. Loaded they weighed 52,000 lbs., and were the first American planes to use sea wings instead of outboard floats. They were soon followed into the air by Martin's giant Russian Clipper, which again raised the world's record for flying-boat weight; loaded, the ship weighed 62,000 lbs.

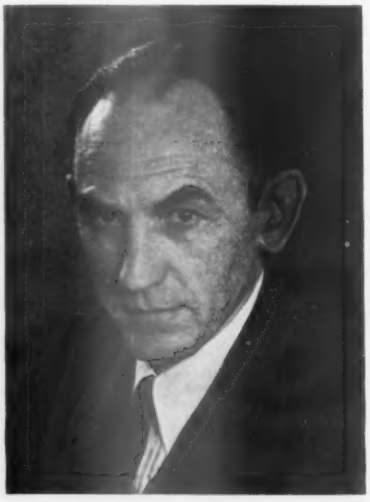
Now came rumors of wars and then wars. Martin engineers ran up the 167—the Maryland—and sent it to the French and then to the British. Soon its exploits, especially over the Mediterranean, were sharing the headlines with the deeds of other American-built planes. The 167 became the 187 or Baltimore; the news of exploits increased.

Meanwhile Martin engineers sent three more outstanding planes into the air: the B-26, the PBM-3, and the Mars.

The B-26 is noted for its clean aerodynamic form and smooth surface, resulting in high performance and maneuverability. Its wing loading exceeds what was thought possible a short time ago, and it carries more powerful armament than any twin-engined bomber flying today.

The PBM-3 features highly refined hydrodynamic characteristics, exceptional flight controllability, and powerful armament. It is a self-contained unit; it carries quarters and supplies for the crew, enabling it to remain out on mission for days at a time.

Then the Mars, largest flying boat ever to rise off the water. This 140,000-lb. leviathan, created by Martin engineers for the Navy, has helped touch off the nation-wide demand for fleets of giant flying-boats. The Mars can carry unrevealed quantities of matériel or armed men anywhere in the world where there is water. For the Mars, together with the design for a 250,000-lb. flying boat, Glenn L. Martin won recently the American Design Award.



William K. Ebel.

But the creation of actual planes, glamorous as it is, has been only part of the story of the past decade of American aeronautical engineering in which Martin engineers have played their part. There is a constant call for devices to help turn them out, for devices to give them an edge over an alert and ingenious enemy. Here are a few random samples of how, aided by the generous cooperation of our armed forces and scientific institutes, Martin engineers have helped answer that call.

They have designed and built a highly successful bullet-sealing gasoline tank. Cousin to the Mareng (Martin Engineering) cell, this self-sealing tank has ridden home from battle with hundreds of bullet wounds—and fuel to spare.

They have developed and built highly successful power-operated gun turrets.

But new planes do not just rise from the drawing board into the air. The projection of aircraft design into hitherto unexplored realms of greater speeds, higher altitudes, synthetic structural materials and ever greater size has demanded the constant development of new test procedures, new methods of analysis, new engineering tools.

For increasingly accurate wind tunnels, for improved towing basin techniques, for countless mechanical, electrical, chemical and metallurgic developments necessary to meet the War's demands, Martin engineers are happy to acknowledge their debt to the technical branches of the Army and Navy, the National Advisory Committee for Aeronautics, Massachusetts Institute of Technology, Stevens Institute of Technology, Case School of Applied Science, and our great body of organized research whose findings are today pooled in the common interest of providing better weapons for the United Nations.

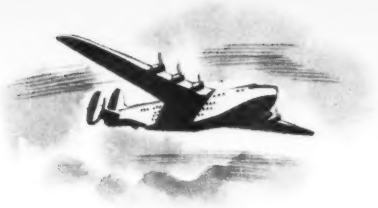
Martin is privileged to include among its contributions to this store of engineering tools a practical and proved solution to the problem of "flutter." This highly destructive phenomenon, which has accounted for most of the structural failures in recent years, can now be measured, analyzed, and *prevented* by the use of test equipment and methods developed, perfected, and applied in practical use by a small group of enthusiastic young engineers who have been working constantly on this problem for more than five years.

Predicting the elastic characteristics of the structure of the Martin Mars, this group has just completed the acid test of methods and equipment under full load flight conditions. The "critical" vibration modes for the various structural elements of the Mars were forcibly induced by means of a power vibrator and the autographs of the damping reactions were obtained for the guidance of designers of tomorrow's greater flying ships—and flashing fighters as well.

Thus Martin engineers have played their part in the past decade of accomplishment by American aircraft manufacturers. They are proud of that part. But most of all they are proud of what the boys on the fighting fronts are accomplishing with the B-26's and PBM-3's and 187's they are sending them.

* Vice-President of Engineering.

Launching THE AIR AGE



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② *Boeing Flying Fortress B-17E*
③ *North American B-25*
④ *Curtiss Commando, C-46*
⑤ *Consolidated Liberator B-24E*
⑥ *Curtiss P-40*
⑦ *Curtiss Dive Bomber SB2C-1*
⑧ *Edo Floats*
⑨ *Plywood Planes*
⑩ *Brewster Buccaneer*

A few of the planes fabricated with Boots Self-Locking Nuts

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The Boots Self-Locking Nut is one-piece, all-metal—withstands severest vibration. The top (locking) section is displaced in a downward direction so that its locking threads are out of lead with the load carrying threads of the lower section.

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Engineering History of North American Aviation, Inc.

RAYMOND H. RICE*

NORTH AMERICAN AVIATION'S history as an active manufacturing concern dates back to 1934 when J. H. Kindelberger became President and General Manager. The company, which operated under the name of General Aviation Manufacturing Corporation until 1935, had previously been a holding company for a number of air lines and manufacturing organizations.

The first two airplanes to be designed by General Aviation after the change of management were the GA-15, a three-place, mid-wing observation plane, later to be manufactured by North American as the Na-25, or the Army O-47, and the NA-16, prototype of North American's famous trainer series.

It is interesting to note that the first NA-16, which was designed in Baltimore, Md., was built in the then record time of 80 days. This airplane was one of the first training types to resemble modern combat craft in general design and handling characteristics. From this model stemmed the Army BT-9. One of the outstanding features of the BT1-19 was its adaptability for rapid maintenance in service. The BT-9A incorporated equipment for gunnery practice, making it especially useful to the Army Air Forces in training its student pilots for combat duty. The BT-9B was equipped for both aircraft gunnery and bombing practice, and had bomb racks similar to the Army A-3 type. The BT-9C differed from earlier models in that it had a fixed machine gun synchronized to fire through the propeller and a flexible machine gun firing from a mount in the rear cockpit.

North American's combat trainers have been built in larger quantity than any other type in the history of aviation. Thousands of pilots of the Royal Air Force, including many of the men who were to win the epic struggle for Britain in combat with the Luftwaffe, received their advanced flight instruction in these trainers. An even larger number of American youths who today are carrying the air war to the enemy received their training in the same type airplanes.

Among the trainers that were the outgrowth of the Na-16 in later years, in addition to the BT-9, were the BC-1, BT-14 and the AT-6 for the United States Army Air Forces; the SNJ for the United States Navy, the first low-wing type adopted by this branch of service; and the Harvard trainer for the British and Canadian Royal Air Forces.

Raymond H. Rice.

The Na-25 was developed into the O-47. The O-47 is a single-engined airplane, carrying a three-man crew in tandem arrangement. The O-47's are still in use, while a group of BT-9's were reported on last May 23 to have passed the 4,000-hour mark at Randolph Field, and, on April 22 of this year, 338 BT-9's and BT-14's flew a total of 2,669 hours and 20 min., a record performance for a single day.

One of the outstanding developments in the early training series should be noted. In these training planes North American became one of the pioneers in the use of arc welding to supplant acetylene welding for the majority of welded steel parts on the ships.

North American's first venture into the twin-engined class was a mid-wing type, known as the NA-21 bomber, which was built in 1937. Its bomb-carrying capacity in relation to its gross weight has not been exceeded by any existing airplane. Interesting to note is the fact that the Na-21 was equipped with hydraulically operated gun turrets in its nose and fuselage, an armament design that represented an outstanding research program on the part of North American.

Another outstanding feature on this airplane was the vertical location of the engine nacelles with respect to the wing. Only a very small portion of the nacelles extended above the upper wing surface, resulting in minimum obstruction to air flow. Also, housing of the landing gear in the retracted position was simplified with minimum cut-out in the critical wing structure.

The proposal predecessor of the B-25, the type that comprised the squadron led by Brigadier General James H. Doolittle to bomb Tokyo last April, was the NA-40, North American's second entry in the twin-engined bombardment class. The NA-40 was the first North American model to incorporate tricycle-type landing gear.

It was particularly gratifying that the B-25's performance exceeded in all cases the contract guarantees by substantial margins. This is attributable to careful design and exhaustive wind-tunnel tests.

Another design now proving its worth in the air war and destined to play a large role in the coming year is the P-51 Mustang fighter. This airplane represents, to a large degree, the maximum in aerodynamic efficiency in the light of present-day knowledge. The Mustang probably represents the most advanced design in pursuit construction in the world today. The wings were designed by methods developed by the N.A.C.A.

A field service department, integrated with the Engineering Department, provides trained representatives to work in cooperation with our Air Forces and other customers throughout the world. North American operates an Air Forces Mechanic Training School to train Army personnel in the operation and maintenance of B-25 bombers.

The North American Engineering Department was the first to make use of the X-ray template system. This process was worked out in cooperation with General Motors and Eastman Kodak Company research men.

In the limited space provided for this article, it has been possible only to give the barest details of the engineering developments of North American Aviation in the past few years. Naturally wartime restrictions render a full report of recent and present engineering activities impossible. We are engaged in our wartime task with an engineering organization that has a solid foundation of experience behind it, and we are confident that the organization will be equal to any problems thrust upon it.

* Vice-President and Chief Engineer.

STOPS 'EM ON ICE

One of the slipperiest problems up North was the landing of 25-ton planes on glare ice or hard packed snow without an expensive crack-up. The ice formed a perfect lubricant for rubber tires regardless of the tread design—turned the tires into sled-runners, sent the plane into the next county.

This problem that had to be solved was put up to United States Rubber Company engineers.

Result: a tire that has turned ice fields into landing fields—the U.S. Royal "Ice Grip Tread" covered with rubber buttons, the outside rows of which have crimped steel "bottle caps" imbedded in them. These sharp metal edges bite into the ice and snow when the brakes are applied and, it is reported, stop the plane as quickly on ice as ordinary tires do on a dry concrete runway.

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Northrop Aircraft, Inc.

W. J. CERNY*

ALTHOUGH the corporate life of Northrop Aircraft, Inc., is only a little over three years, the majority of the key men in the Engineering Department have worked together for from ten to fifteen years. Operating as a group in previous corporate associations under the leadership of John K. Northrop they have been responsible for many engineering advancements over the past decade.

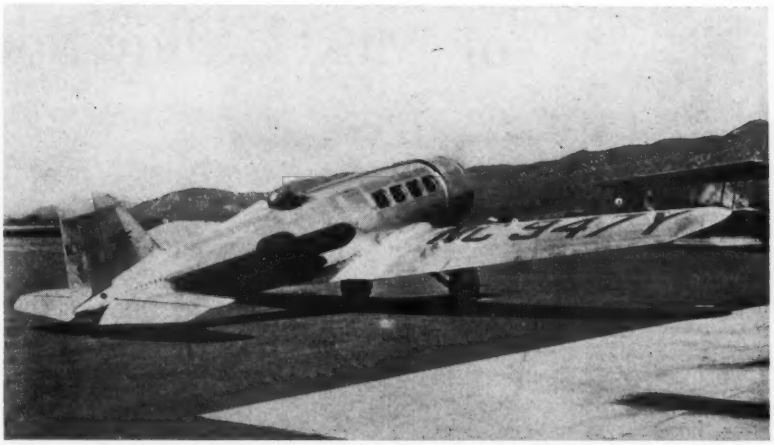
It was this group of Northrop engineers who, in 1930 perfected the wing-fuselage filleting system now nearly universally used in low-wing monoplanes. The same airplanes were among the first to use rubber vibration damping in engine mounts. They likewise pioneered the monocoque metal structures widely used in hundreds of commercial transports and military airplanes throughout the world.

In 1932 the first commercial use of split flaps was introduced by the same engineering group. At the same time the use of structural magnesium alloy castings was investigated and introduced extensively in production airplanes. Later, the first low-wing, full cantilever fighter aircraft was developed, and in 1935 a 300-m.p.h., all-metal, low-wing pursuit was produced

John K. Northrop, President and Chief of Design.

which was the forerunner of the thousands of similar ships that have gone into production since that time. One of the largest orders ever let for aircraft in the prewar period was for over 250 Northrop A-17 and A-17A attack planes delivered to the War Department in 1936 and 1937.

* Assistant Chief of Design.



Northrop "Alpha" used by Transcontinental & Western Air, Inc., to inaugurate the first 22-hour east-west mail service.

At about the same time the XBT-1, first of the long series of dive bombers, now known as the SBD, was designed. This plane incorporated one of the first successful air-brake installations now used in almost all dive-bombing airplanes.

After incorporation of Northrop Aircraft, Inc., in August, 1939, the same engineering nucleus was reassembled and, starting with about fifteen men, was gradually increased in size to the present staff of nearly 400. The first project undertaken by the new organization was the design of the N-1 "flying wing" that was built in an endeavor to determine the problems and advantages of the age-old concept of the tailless all-wing type. This plane was first flown in July, 1940, and since that time has been used as a flying laboratory in which the effect of scores of aerodynamic modifications have been investigated. It is the opinion of the company that the experiments carried on to date have been well worth while and that the type holds promise for the passenger and freight transports of the future.

In the meantime more conventional designs have progressed in the Engineering Department. In 1940 a small quantity of twin-float, Cyclone-powered seaplanes were ordered by the Norwegian Government. The first of a new design was flying within nine months of the contract date, and 24 were completed within 375 days from the date the first preliminary layouts were made. Twelve of these planes have been operated under the R.A.F. by the Royal Norwegian Air Force doing submarine patrol duty off Iceland for the past year and have several submarines to their credit.

Northrop engineering and shop personnel have cooperated in a number of developments to speed the war effort. One of these is the successful application of electric arc welding to magnesium alloy structures. This process, under active investigation for over two years, permits the attachment of magnesium parts without the use of a flux and, therefore, without danger of flux inclusions and resultant susceptibility to corrosion.

Another new process permits aluminum alloy assemblies to be cleaned just prior to spot welding in a special bath that eliminates all previously required individual cleaning of parts and saves hours of assembly time. A third development permits the quick and accurate production and duplication of all types of templates from an original layout by means of an etching process that saves hours of layout, cutting and filing in the manufacture of such parts. Many special machines for speeding war work have also been developed or perfected in Northrop shops. Among these may be mentioned a special extrusion bending machine and a battery of electric heat-treating furnaces for aluminum alloys, in which the time from furnace to quench is less than 2 sec.

The past record of the Northrop organization has been one of continual advance, pioneering and contributions to the aeronautical industry. When the war is won and the full story can be told, it is believed the advertising slogan, "Watch Northrop," will be fully justified.

Data on Relaxation Resistance of Nickel Alloy Springs

Report presented at 1941 Annual Meeting of the American Society of Mechanical Engineers now available in printed form

The oxidation and corrosion resistance of INCO Nickel Alloys, combined with ability to retain strength at elevated temperatures, have made them useful in many elevated-temperature spring applications. When load loss at temperatures from 300° F. to 700° F. is a criterion, "K" Monel, "Z" Nickel and Inconel are comparable to high-alloy spring steels, while Monel is more nearly comparable to low-alloy steels.

Members of the INCO Laboratories and Development and Research Division, in cooperation with the A.S.M.E. Special Research Committee on Mechanical Springs, have now furnished accurate laboratory data for Monel*, "K" Monel*, "Z" Nickel*, and Inconel*, which point to the following conclusions:

1. Inconel resists relaxation up to high temperatures and may be used at high stresses up to 650° F. Above this temperature the stress must be lowered considerably and a slight degree of relaxation must be tolerated.

2. "Z" Nickel and "K" Monel will withstand higher stresses than Inconel at the lower temperatures, consistent with their generally higher level of mechanical properties.

3. "Z" Nickel may be used with high stress at temperatures up to 550° F. and with reduced stress up to 600° F.

4. "K" Monel may be used with high stress up to 450° F. and reduced stress up to 500° F.

5. Where other factors such as corrosion resistance are involved, Monel offers possibilities as a spring material for temperatures up to about 400° F. and at moderate stress levels.

6. Monel springs should be stress-equalized for 1 hr. at 650° F. where relaxation resistance is desired.

7. Inconel springs should be stress-equalized for 1 hr. at 900° F. for service at elevated temperatures.

Complete technical information on this subject has been published in bulletin form. You are invited to send for this paper by using the coupon below.

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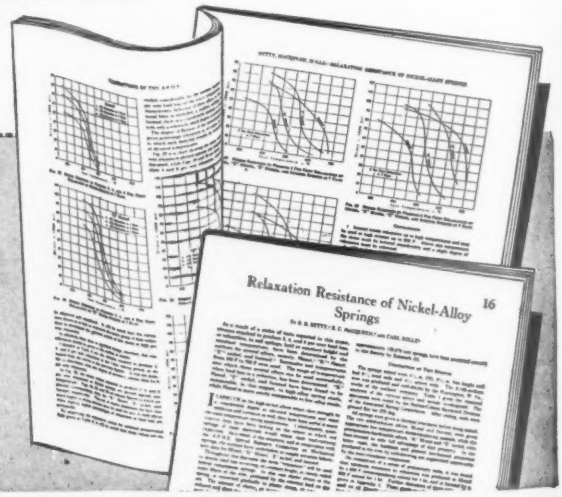

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Engineering Progress at the Piper Aircraft Corporation

W. C. JAMOUNEAU*

IN ORDER TO PROVIDE a proper background for the description of engineering advances made in the design of Piper products, it is necessary to review briefly the constructional features of the first "Cub," which was built in the summer of 1930. This airplane, successfully flown one month from the date of the inception of the design work, was originally powered with a two-cylinder horizontally opposed Brownbach "Kitten" engine. As additional power was needed, a Salmson nine-cylinder, 40-hp. radial engine was fitted to the airplane. Later, the Continental 37-hp. four-cylinder, horizontally opposed air-cooled motor was selected as being the most suitable for use.

In 1932, at the Cleveland Air Races, a 37-hp. Cub was used to tow a glider; the same horsepower operated Cubs commercially at western fields at over 7,000 ft. altitude; and a few years later two Californians culminated a wave of endurance flights by staying aloft in a 50-hp. Continental Cub for 726 hours.

A number of features of design were incorporated in the first Cub airplane. Among the noteworthy items were aluminum alloy ribs consisting of drawn sections riveted into a truss. Particular care was taken in the detailed design to avoid the use of machined fittings in order to reduce the amount of labor necessary to produce this airplane.

In the fall of 1935 the first major modifications were incorporated in the Cub, consisting of the reshaping of the tail surfaces and wing tips and a redesign of the fuselage fairing. A built-in cabin enclosure and an improved seating arrangement completed this redesign.

A Piper-designed ski was produced in 1936. This ski was constructed of a solid ash base with a tubular steel pedestal and was interchangeable with the standard wheel equipment. In the same year synthetic rubber fuel lines were placed in production.

In the early part of 1937 the buildings and equipment of the Taylor Aircraft Company at Bradford, Pa., were completely destroyed by fire, necessitating a complete retooling and replacement of inventory. Operations were continued at Bradford for several months after which time it was decided to move to Lock Haven, Pa.

Piper TG-S (towing glider).

In the fall of 1937, the Cub was again revised and a number of unique production processes were instituted. Among the innovational production features might be mentioned a "ferris wheel" on which wings and fuselages are sprayed with dope. The first units in a mechanical conveyor system were installed to facilitate the handling of large parts such as complete fuselages and wing panels. One of the design features on the redesigned Cub consisted of the installation of hydraulic brakes of the Goodrich-Palmer type.

In 1938 the first side-by-side seater, the Coupé, was designed to fill the need for a private-owned airplane. This airplane was the first Piper-designed product to incorporate a hydraulic type landing gear shock absorber strut.

In 1939 the Piper Cruiser, a three-place enclosed monoplane, was designed. This model has been widely used for passenger carrying, and for student instruction purposes a number of airplanes of this model have been equipped with blind-flight instrument panels. In the same year a pressure cowling was fitted to the Coupé and a stainless-steel muffler was designed to reduce the volume of exhaust noise, thereby increasing passenger comfort.

In conjunction with the Edward G. Budd Manufacturing Company, the tail surface structures were redesigned to incorporate spot-welded stainless-steel construction.

In 1940 phenolic-glued plywood floats were installed on the Cub. The wing construction of the Coupé was redesigned to make use of aluminum-alloy extrusions for wing spars.

Considerable development work has been performed on aircraft fabrics and dopes consisting of the use (experimentally) of glass fabric and rayon fabric. The hot dope process has received considerable attention and several airplanes have been finished by this method.

During the current year the Cub has been converted to a liaison airplane for Army use in which a considerable portion of the turtledeck has been covered with transparent sheeting and a reversible rear seat has been installed. The Cub has also been modified in another version to permit the installation of a front seat in place of the engine, thereby making a three-place glider.

The three-place Cruiser has recently been modified somewhat to accommodate the installation of a 100-hp. engine enclosed in a pressure cowling and the landing gear has been streamlined to improve the performance. A further modification of the Cruiser consists of the installation of a stretcher in the rear section of the cockpit, permitting the transportation of patients.

Throughout the history of this company every attempt has been made in design to make it possible to produce and sell airplanes at a minimum price. These studies have resulted in the use of a number of materials now accepted as standard in aircraft construction. Notable examples of materials of this type are seam-welded steel tubing and light airplane fabric.

* Chief Engineer.

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United Aircraft Corporation

FRANK W. CALDWELL*

THE FOUNDERS of United Aircraft Corporation realized from the beginning of its operation that, in common with the rest of the aviation industry, it had two major responsibilities to the nation in the event of a war emergency: first, that it must always have available for production superior types of airplanes, engines and propellers; second, that it must have the ability to put them into production quickly.

It is that first responsibility with which this story is primarily concerned—the responsibility for technical superiority.

There is no space here to dissect and analyze completely the performance of United Aircraft's three divisions in discharging that responsibility, and the limitations of military secrecy would preclude any discussion of many of the most important engineering projects of the past few years.

PRATT & WHITNEY

But the picture can be painted in broad, sweeping strokes. Each of the three divisions of the corporation has made vital contributions to the design of aircraft that our armed forces are finding priceless in this air war. At Pratt & Whitney Aircraft, for example, perhaps the simplest measure of technical performance is the fact that a proved 2,000-hp. air-cooled radial engine is in quantity production. Aeronautical experts will tell you that there is no substitute for power and that no other country in the world has engines of this tremendous power output in production.

HAMILTON STANDARD

At Hamilton Standard Propellers, the simplest measure is the fact that its constant-speed types of propellers are used on three-quarters of all the advanced training and combat airplanes built in the United States at this time. Again, no other country in the world has perfected equipment of this caliber.

VOUGHT-SIKORSKY

At Vought-Sikorsky Aircraft, again the simplest measure of technical development is the Corsair fighter. This airplane, in the 400-m.p.h. class, has been widely hailed as the finest Naval fighter in the world. As a matter of fact, it is an outstanding example of the technical contributions of all three divisions, for its advanced aerodynamic design is built around the 2,000-hp. Pratt & Whitney engine and the latest Hamilton Standard Hydromatic propeller. The combination of advanced engine, propeller, and airplane design has produced what is expected to be one of the Naval air service's most potent weapons.

ENGINE DEVELOPMENT

These outstanding examples, of course, are only symbols of the intensive research and experimentation that has been going on at a steadily increasing tempo in all three divisions. The 2,000-hp. Double Wasp engine is the fruit of more than ten years of pioneering development by Pratt & Whitney of the basic design of the two-row radial engine. Concomitant with this has been a heavy and varied program of research on allied design problems—the development of improved superchargers, radical improvement in cylinder cooling, perfection of new types of bearings, important contributions to the design of engine cowls, carburetion systems, and many others.

PROPELLER DEVELOPMENT

At Hamilton Standard, the Hydromatic quick-feathering propeller is similarly the culmination of a long research program that first produced the controllable-pitch propeller without which the high performance of the modern airplane would be impossible. Linked with this has been an achievement of equal importance—the development of a stress measurement technique that has minimized propeller breakage to the vanishing point and is now mandatorily applied to all types of propellers before they are approved for military or commercial use. In addition, the engineering staff has studied and made important contributions to a wide variety of problems including those of operation under all conditions of weather and temperature, the design of more efficient blades and mechanisms, and improvement of materials, as well as a continuing study of the difficulties involved in flight at extremely high altitudes.

AIRCRAFT DEVELOPMENT

At Vought-Sikorsky, the new Corsair fighter is again only one of the symbols of an aggressive technical development program. By way of contrast, there is the Sikorsky helicopter, a successful vehicle that can go straight up or down, hover, or fly in any direction including backwards. Another outstanding result is the new VS-44A flying boat, said to have the longest range and the highest performance of any of the large flying boats now in service. This is a direct result of the pioneering work of this organization, which first achieved what was considered impossible only ten years ago—the development of a successful flying boat of more than 20 tons gross weight. Behind all these, as in the case of the other divisions, is the same story of always painstaking and often brilliant research that has made many important contributions to the science of aerodynamics itself as well as to the design of outstanding types of aircraft.

And this is only part of the story. These are only the things that can be told. There are many more that must remain untold for the present, but in secret hangars, in locked laboratories and in guarded test cells, newer and better airplanes, engines, and propellers are being created to carry American air superiority still further.

INDUSTRIAL COOPERATION

All of this adds up to one fundamental fact: that, in discharging so well their responsibility for technical development this small group of men has helped make it possible for industry to discharge its second responsibility—the quantity production of this desperately needed equipment. One has only to look at the production scoreboard to know that this is so. United Aircraft, in addition to its own burgeoning production, has enlisted perhaps the greatest industrial team in history to build its products—such names as Ford, Buick, Chevrolet, Nash-Kelvinator, Jacobs, Continental, Frigidaire, Remington-Rand, Brewster, and Goodyear. Right now these great organizations are thundering into production on these same Pratt & Whitney engines, Hamilton Standard propellers, and Vought-Sikorsky airplanes to defeat our enemies. They are devoting an unprecedented amount of man-hours to the production job, but every man-hour has been made possible only by the millions of "brain-hours" that have been unsparingly given to the creative tasks by United Aircraft in the lean years through which the aviation industry has struggled.

* Director of Research.

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Vultee Aircraft, Inc.

A. P. FONTAINE*

COINCIDENT with the founding of the Institute of the Aeronautical Sciences, development work was started by the Airplane Development Corporation (forerunner of Vultee Aircraft, Inc.) on the first airplane to bear the Vultee name. This airplane was the single-engined transport designated the V-1A, incorporating in its design many advanced features including landing flaps, retractable landing gear, and full cantilever construction, and which was among the first airplanes available to the air lines that made possible the high-speed, economical air-line transportation we know today.

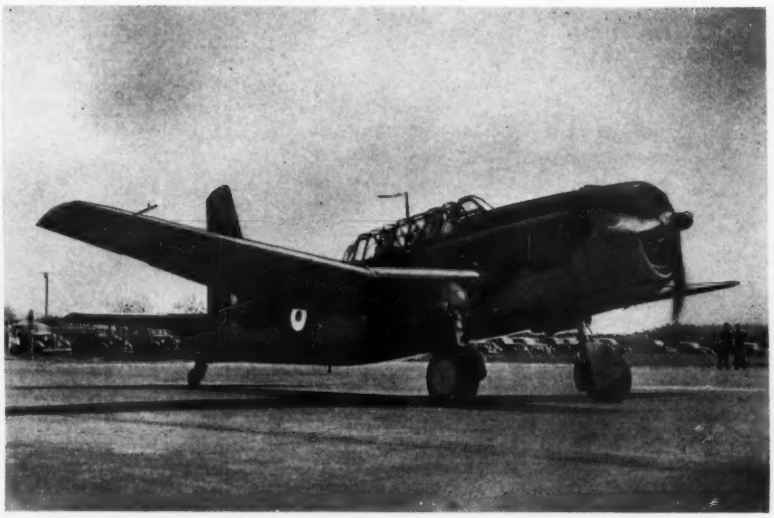
Based on the experience obtained from the V-1A, the V-11 attack bomber was developed and produced. The design of the V-11 represented the advent of a new type airplane that enjoyed sales to many foreign countries, as well as to the United States Air Corps, and was Vultee's introduction to the design and production of military aircraft. The variety of missions for which this airplane was suited made it particularly valuable to countries whose air forces were limited in size.

STINSON DEVELOPMENTS

During this period when the development of medium-sized transport and military airplanes was being carried out by the Airplane Development Corporation, the style trend for light commercial private airplanes was being set by our Stinson Division. The place of the Stinson name in the field of light commercial airplanes is well known. This organization was also responsible for the design and development of the L-1 Army Liaison Airplane, which was the first type in this particular field. Because of the use of improved lift-increasing devices and other design features, this airplane could take-off and land over an obstacle in a shorter space and could hover at a slower speed than any other airplane built at that time. Today there are many types of liaison airplanes which have been developed from this original design.

THE BT-13 BASIC TRAINER

An outstanding airplane currently being produced by Vultee is the BT-13 basic trainer. This airplane is now the standard basic trainer for both the Army and Navy Air Forces of the United States. It was selected for this job because of its outstanding performance and handling characteristics, as well as the ease with which its structural design lends itself to mass production so necessary to meet the ever increasing demands in pilot training.



The Vultee Vengeance.

DIVE-BOMBER DEVELOPMENT

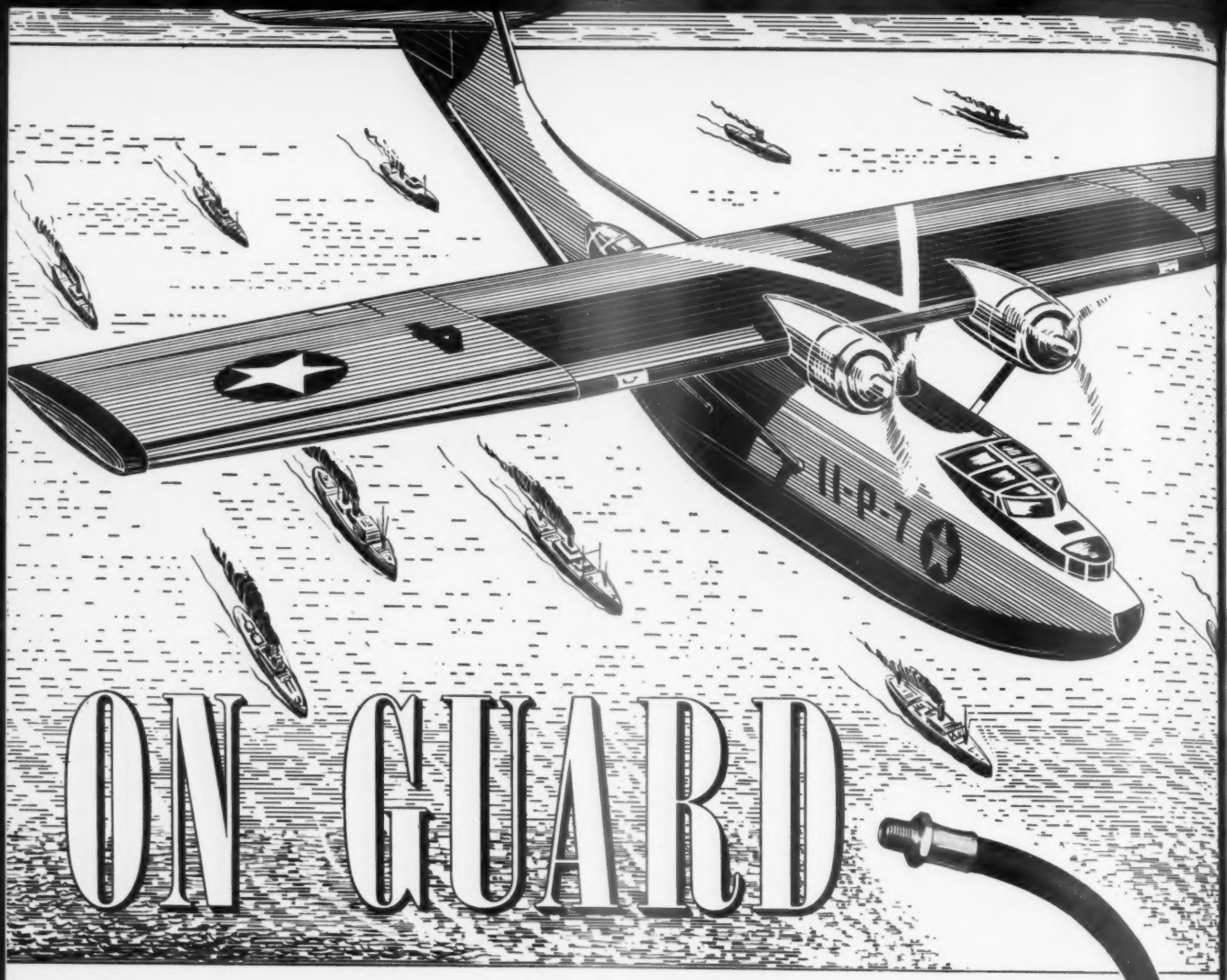
Our Vengeance dive-bomber development, which was started after the outbreak of the European War, had incorporated in its original design features such as heavy armament, armor plate, and fuel protection which was found to be so necessary in the early battles of this war. This airplane carries a heavier bomb load at a higher speed than any airplane of its type in use by the Axis. These airplanes are now being produced in quantity at our Nashville plant for both the British and the United States air forces. Up-to-the-minute improvements on this basic design are being carried out by our Nashville Division Engineering Department.

Each succeeding model or type has presented new problems, the solution of which has added further to our fund of knowledge. Many special investigations have been conducted such as the effect of wing plan form on the stall characteristics of airplanes, compressibility effect, development of satisfactory dive brakes, and others. The study of control hinge moments carried out with particular reference to the Vengeance, but of general interest because of the necessity for maintaining light stick forces on large airplanes, has resulted in the development of a spring servo tab in which the movement of the tab is relative to the force necessary to move the surface rather than relative to the angular displacement of the surface itself. This principle has been proved to a point where it is now being incorporated in production aircraft.

Since a large part of these special investigations must be carried out in flight, the necessity for the development of an instrument capable of measuring and recording the reactions of the various airplane components automatically during the actual flight has long been felt. Such an instrument has been recently developed by Vultee and has been tested and proved sound. This development will enable the aircraft designer to obtain information heretofore not available during actual flight, such as stresses in the various parts of the structure, cable loads, control-surface displacement, etc. In addition to the data mentioned above readings from the standard instruments normally observed by the pilot are also handled by this instrument.

Vultee has established laboratory facilities and is constantly augmenting them to better carry out the investigations necessary for the development of airplanes while in the experimental stage. These facilities include our own wind tunnel, power-plant cooling test tunnel, and the various structural, chemical and cold-room laboratories needed to meet the problem of high-altitude flying, material substitutions, and other factors that the aircraft designer is confronted with today.

* Vice-President.



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Allison Division, General Motors Corporation

R. M. HAZEN*

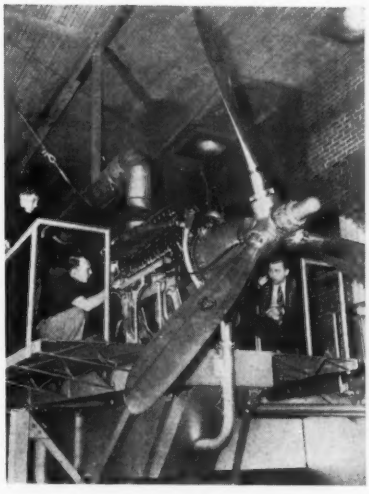
In March, 1932, the Allison GV-1710 engine passed its first acceptance test for the U.S. Navy; 750 hp. at 2,400 r.p.m. Few realized it at the time, but this event was to open a new chapter in the history of the Allison Engineering Company and the progress of American aviation. The V-1710 had its inception three years before, when N. H. Gilman, studying the rising curve of engine powers and airplane speeds, concluded that the future would demand much more powerful engines, streamlined to minimize drag and laid out the Allison engine for 1,000 hp., with 750 hp. set as the immediate goal for the first stage of development.

Allison had already built up a unique reputation in the aircraft field. A small group of engineers and craftsmen were pioneers by habit and choice, under a policy laid down by Jim Allison that ignored profit but demanded achievement. Among their notable accomplishments were the development, first in America, of propeller reduction gears and extension shaft drives; improvements and modernization of the Liberty engine; and the famous Allison bearing, which revolutionized airplane engine design the world over. General Motors acquired the company in 1929 and the Allison group were afforded additional facilities for the furtherance of developments.

A second Navy model, a reversible engine, was developed to replace the German Maybach engines in the *Akron* and *Macon*. One of these completed a model test at 650 hp. and two were built for service trial.

Meanwhile the Army had become interested; the need for more power had become obvious. The result was a series of contracts to develop the V-1710 through a 1,000-hp. type test. Progress was slow, for the tiny Allison shop could produce only one engine at a time and it required months to replace a single broken part. But in June, 1937, the V-1710-C8 successfully completed its 150-hour type test at 1,000 hp., the first engine ever to attain this official rating. The Allison engine had arrived.

First to use the new engine were the Bell XFM-1 (Airacuda) and the Curtiss XP-37. Both demonstrated the flexibility of design made possible by this type of engine. The Airacuda used two pusher propellers driven by extension shafts; a radical type of plane, it showed sensational performance but was later replaced by the Airocobra, P-39. The history of the P-40 is too well known to need repeating. With the acceptance of the engine for service, a new factory was built with a capacity of perhaps 100 engines per year. That was before Munich.



The Allison V-1710 undergoing tests.

The real expansion came in 1939 when, under the ominous threat of war, the strengthening of American defenses and the urgent needs of the British multiplied the demand. The result was a new plant and a new production setup that smashed all precedent. This plant, erected and occupied in six months (June–November, 1939) set the pattern for today's modern windowless, air-conditioned war factories and pioneered in all-out mass production, in the training of unskilled labor to operate precision machines, and in the extensive dependence upon subcontractors—Cadillac, for example, furnishes crankshafts, connecting rods, and complete reduction gear assemblies. The first proud goal was 100 engines per month, but with actual war this figure was soon forgotten. In November, 1941, production reached 1,000 engines per month. Since Pearl Harbor, of course, production figures are not published, but factory construction continues.

Although tests indicated that several hundred more horsepower awaited only further development, the C-15 design did not permit the flexibility desirable for future developments. Lockheed wanted right- and left-hand engines to balance torque reaction; Bell wanted a long extension shaft with a remote reduction gear to permit a cannon to fire through the propeller shaft. To meet these and future requirements a new engine was designed—one basic engine that could be assembled into a wide range of models while still retaining a high degree of interchangeability.

The new engine started in production April, 1941, in two models, V-1710-E and F. The basic engine is exactly the same for both, and the different models take form only at the final steps of assembly. For the F model, a reduction gear case (furnished complete by Cadillac) is bolted to the front end; for the E, a simple cover plate and a coupling to take the extension shaft. Supercharger gears, of course, can be changed as required. By turning the crankshaft end for end and changing a handful of small parts the engine can be reassembled, in the shop or in the field, for either right-hand or left-hand rotation. And from the first engine to the present day all major parts of the basic engine, all subassemblies, and most of the individual minor parts are interchangeable between engines and between models. The advantages to production and service are obvious and outstanding.

The curve of engine power continues to rise and as yet shows no sign of leveling off. In October, 1940, a military rating of 1,150 hp. was established by model test on the sea level F-3, and soon after the same rating was reached in the E-4 at 12,000 ft. altitude. In May, 1941, Allison became the first to attain the long-sought goal of 1 hp. per lb., when the F-5 completed a successful model test at 1,325 hp. military and take-off rating. It weighed 1,303 lbs.

Many advances in design and metallurgy have been developed by Allison in cooperation with General Motors Research, other G.M. divisions, and foundrymen, and these have all been made available to the rest of the aircraft field. Of particular interest are shot-blasting to improve the fatigue strength of highly stressed parts such as connecting rods; new developments in patterns, core design, and foundry technique; and new heat-treatments that have increased the fatigue strength of aluminum castings by reducing internal stresses.

* Chief Engineer.

...dish it out!

In the skies...and from the skies... your warplanes dish it out, America! Your fighters...and your bombers...now sweep the skies they choose. They're blasting on the offensive...not taking it according to Axis schedule.

But at home, America...you've got to dish it out, too. In this fight, the pay-off is for dishing it out on *all* fronts of total war...everywhere.

America's planes have *quality*...and your flying forces are getting them in *quantity*. Backed up by a united, fighting America, they're a combination that can make inevitable the air mastery of the United Nations.

For this mastery, Lockheed builds the P-38 Lightning, the world's fastest two-engine fighter...*officially*...and the Lockheed Hudson bomber. Lockheed Aircraft Corporation...Vega Aircraft Corporation...Burbank, California.

for protection today, and progress tomorrow, look to

Lockheed

FOR LEADERSHIP

The Decade for Jacobs Aircraft Engine Company

CHESTER E. MINES*

TWO HUNDRED YEARS AGO the iron and steel industry of America was born at Pottstown, Pa., when the first iron works was established by John Potts near the town which now bears his name. Forty years ago the aluminum casting industry of America was born at Pottstown when the Light Manufacturing and Foundry Company began experimenting with aluminum castings for the then infant automobile industry. Ten years ago the Light Company was liquidated after an enviable record of 25 years of continuous manufacturing of gasoline engines for motive power, including the aircraft engines designed by H. L. Brownback.

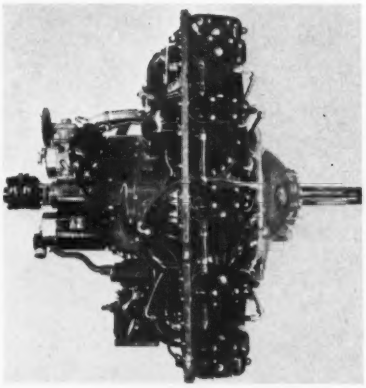
Today, on the same acreage in Pottstown, the Doehler Die Casting Company is producing aluminum castings for the aircraft industry, and in the enlarged factory of the former Light Company aluminum castings are being assembled into Jacobs aircraft engines, which are flowing to the United Nations in ever increasing numbers.

Ten years is not quite enough to cover the history of the Jacobs Aircraft Engine Company which dates back to a little earlier than the issuance of its first Approved Type Certificate No. 31 on February 7, 1929 on the 140-hp. Model LA-1 engine for which the development was started in 1927. Before and after moving from Camden, N.J., to Pottstown in 1932, the company bearing the name of its founder and present director of engineering, Albert R. Jacobs, was producing the seven-cylinder LA-1, which had been raised to a 170-hp. rating and the three-cylinder Model L-3 of 55 hp.

Confining its field of endeavor strictly to air-cooled radial engines in the medium horsepower class, Jacobs has successively given to the aeronautical world in 1934, 1936, and 1938, the L-4, L-5, and L-6 models of seven-cylinder engines with ratings of 225, 285, and 330 hp., respectively. These engines are also known by the designations R-755, R-830, and R-915, these figures referring to cubic inch displacement.

Substantially identical in design, and of a type which is fundamentally sound because of its simplicity, these engines have, nevertheless, incorporated a number of unusual features that have proved to be of great value to aircraft designers and operators.

* Resident Chief Engineer.



Jacobs Model L-4MB Engine (R-755-9) equipped with magneto-battery ignition.

One of these has been the omission of nearly all small accessory drives from the engine accessory case proper. The rear crankcase section of the engine thus provides accommodation for only the starter, generator, oil pump, fuel pump and ignition units. In addition to these there is provided a single drive that can be equipped with any one of a large variety of "accessory drive units." These units carry from two to four small drive pads that are specifically designed to receive and drive at the proper speed ratio such small accessories as the propeller governor, instrument vacuum pump, hydraulic pump, fuel pump, or machine-gun synchronizer. The usefulness of this feature to the airplane designer who must battle "interferences" in his powerplant installation is doubled by the fact that the required accessories can be varied in combination and arrangement.

Unlike the majority of American radial engines the crankshaft of the Jacobs engine is not cut off immediately behind the rear main bearing. There being no supercharger, the crankshaft is extended full length to the rear of the engine. This arrangement has made it easy to provide a special model in each of the three engine sizes, in which a rugged and powerful drive connection is designed for use as a rotor starting drive in the autogiro type of rotating-wing aircraft. The majority of autogiros built in this country have been powered with 225-hp. Jacobs engines.

The development of the autogiro for the take-off necessitated increased power for accelerating the rotor. To meet this requirement it has been necessary to design one recent model of Jacobs engine for autogiro application for the very unusual condition of delivering half the rated power output of the engine through the rear end of the crankshaft to the rotor starting drive.

The original model of the Jacobs L-4 engine introduced the use of battery ignition for the first time as standard equipment on a modern radial engine and, with the exception of a few two-magneto engines, all Jacobs engines have since had either all battery ignition or a combination of magneto and battery ignition.

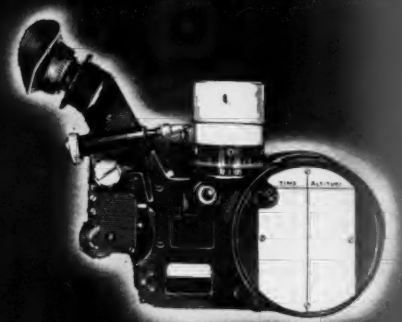
Jacobs' development work has been applied to the continuous improvement of engine reliability rather than to any effort to obtain increased power output from models of a given displacement. Always ready to adopt sound engineering and metallurgic improvements, Jacobs engines have been among the first to utilize such developments as aluminum alloy link rods, nitrided steel knuckle and piston pins, extensive use of magnesium alloy castings for nearly all major crankcase sections as well as other stressed parts, the use of shot blasting instead of polishing to improve the fatigue resistance of highly stressed steel master and articulated rods, and the adoption of self-locking Elastic Stop Nuts for substantially all exterior fastenings. The result of this policy is an outstanding record of reliable engine service—whether air-line operation in India, Northwest Canada, or South America—commercial pilot training for transoceanic flying or private company transport—or, as today, piling up thousands of flying hours training the bomber pilots of the United Nations.

By the pioneering of such manufacturing innovations as the diamond boring of articulated rods and of knuckle pinholes in master rods, the single operation finish grinding of cylinder barrels, the multipurpose adaptation of Delta drill heads, the wider use of die cast and permanent mold cast light alloy parts, and the infrared drying of paint, Jacobs has led the field in the production of engines for advanced military training.

With a huge new factory now swinging into operation, Jacobs has joined the group of companies manufacturing Pratt & Whitney engines under license, and in addition to its own engines, will build R-985 Wasp Junior engines.

Star Gazer

OF "THE INVISIBLE CREW"



On board the first Pan-American Clipper to span the Pacific was an Octant, appropriately bearing the name Pioneer. Today, Pioneer Octants fly with all the Clippers; and with our great service airplanes that cover vast stretches of water on regular and special missions. For at sea, or over uncharted territory, the Pioneer Octant gives the navigator his only possible 'fix'"—through measuring the angular altitude of a celestial body. Like the Octant which helps our navigators to "shoot the stars", the other Pioneer precision *Navigation Instruments* help our flying Americans to keep our star of victory in the ascendency.

Products of the Pioneer Instrument Division are important members of "The Invisible Crew", which includes the precision instruments and equipment built by 15 Bendix Divisions, serving with our fighting crews on every front.

THE INVISIBLE CREW

Precision Equipment by Bendix

AVIATION CORPORATION

PIONEER INSTRUMENT DIVISION

Menasco Manufacturing Company

WILBUR G. WOOD*

Wilbur G. Wood.

UNTIL THE PAST YEAR, the Menasco Manufacturing Company engaged primarily in the manufacture of in-line, air-cooled, aircraft engines of the smaller horsepower ratings for use in commercial and racing aircraft. Probably most people will remember Menasco as having powered several racing types that competed in past National Air Races and other racing events. In this connection, it is interesting to note that Menasco-powered ships competed in the Bendix, Thompson and Greve races from 1933 to 1940. Menasco powered half the entrants in the above events, winning an appreciable majority.

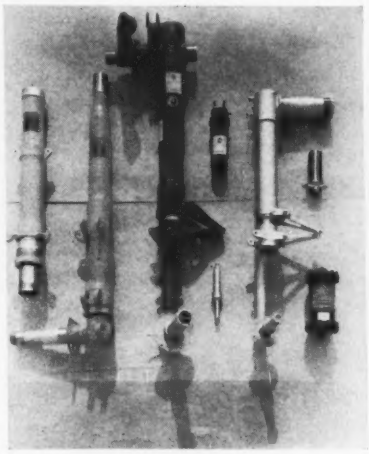
The manufacture of racing engines, however, by no means represented the major activity of the Menasco Company. The Company for the past 13 years concentrated on the production of in-line, air-cooled engines primarily for use in commercial aircraft. Approximately ten models were produced for commercial use with horsepowers ranging from 50 to 290. The most popular of these have been the C4, 125 hp.; C4S (supercharged), 150 hp.; D4, 125 hp.; and the C6S-4, 250 hp. These models have flown in every corner of the world. Another model, the B6S which powered Col. Charles Lindbergh's Miles-Mohawk, won fame on his extensive tour of Europe and the Middle and Far East.

Menasco engines have been used in the training programs of the governments of the Netherlands, Netherlands East Indies, Union of South Africa, China, as well as those of Guatemala, Mexico, the United States of America, and Canada.

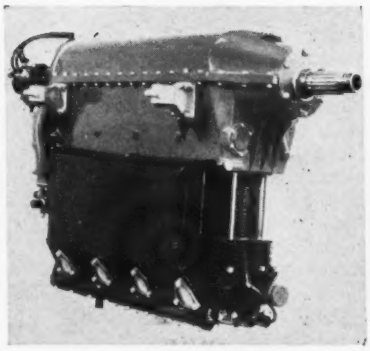
Perhaps the most popular installation was in the Ryan ST series; however, Menasco engines have also been used in Rearwin, Stearman-Hammond, Fairchild, Waco and the DeHavilland Gypsy Moth airplanes.

In 1940, Menasco Manufacturing Company undertook the production of shock absorbing struts. Although this radical departure from the established business of the Company required new techniques as well as completely new machine tool equipment, it met with immediate success. Repeat orders quickly followed, and the Menasco company became firmly established in the manufacture of aircraft shock absorbers.

Just a year after Menasco entered this new field of business, the War Production Board recognized an acute shortage of facilities for producing aircraft shock absorbers. Immediate steps were taken to expand existing facilities and to establish new sources for these vital aircraft components. Because of the seriousness of this situation, the Menasco Company decided to devote almost all its energy to the production of shock absorbers. The Company's new engine plant, which had been completed less than a year, was converted for this task. The Defense Plant Corporation assisted in the expansion of the adjoining strut plant, thereby increasing Menasco's capacity for shock-strut production by several fold.



Menasco aircraft hydraulic struts.



Menasco Model D4 125-hp. engine.

An Engineering Department was established for the design and development of aircraft shock absorbers. The personnel that was selected for this department gave to Menasco the advantage of many years of experience in this field.

Landing gear drop testing equipment has been installed so that the performance of a new design of shock absorber strut may be thoroughly proved before it is flown on the airplane. Continual research is being carried on for the improvement of shock absorber performance and the development of new processes for manufacturing.

A few items other than shock absorbers are now being manufactured by Menasco. These are mostly small hydraulic units for installation on airplanes and constitute only a small percentage of the Company's production.

Outstanding success has been scored by the Menasco Manufacturing Company in the production of aircraft shock absorbers in large quantities. The high standards of quality demanded by the aircraft manufacturers have been strictly adhered to even though high rates of production have been quickly achieved and continuously maintained.

The immediate task of the Menasco Manufacturing Company is the contribution of the utmost productive effort to help bring ultimate victory; however, Menasco confidently looks forward to contributing its share to a more peaceful era by maintaining its place in the field of shock strut manufacturing. It also looks forward to the resumption of designing and manufacturing small aircraft engines at some future time.

* Chief Engineer, Hydraulic Division.

Engineering Advances Which Benefit the Aviation Industry

J. G. VINCENT*

In 1932, the same year during which the Institute of the Aeronautical Sciences was founded, the Packard Diesel aircraft engine was awarded the Collier Trophy emblematic of the highest award in American aeronautics. It was the first Diesel engine to fly an airplane, and it set an economy record for internal combustion engines in the first cross-country flight ever made with a Diesel engine. It also established a new airplane world record for the longest period of sustained flight without refueling.

Our liquid-cooled aircraft-engine design lent itself perfectly to high speed on the water. Thus, concurrently with our Diesel development, Packard continued to apply its long experience with liquid-cooled engines to the marine engine field.

The first few years of the Institute's existence also saw Packard-powered boats maintaining a long-standing tradition by making clean sweeps of the Gold Cup races. During the same period the Miss America boats powered by Packard marine engines repeatedly won the Harmsworth races and, in 1933, established a world speedboat record of 124.915 m.p.h.

Mention of the Packard engines in the Miss Americas brings us to a discussion of our marine engine war assignment, for they were of the same type as we are now building for the Navy's motor torpedo boats.

When the Navy sought a super powerful marine engine for its fast PT craft, we had the engine and an experienced engineering and manufacturing staff capable of producing it for Navy requirements. Long before Pearl Harbor, in late 1939, we started building the engines and within five and one-half months began delivering them to the Navy. This early start on our marine engine war work was one of the main reasons why Packard was one of the first automotive companies to switch from car production to practically 100 per cent war production.

Of necessity, these PT boat engines are basically aircraft engines in design, material and precision. Weight of the engine to power such a fast boat is relatively as important as the weight of an aircraft engine is to the fighter plane.

Because of this almost identical similarity between the Packard marine engine and a liquid-cooled aircraft engine, our efforts to give the Navy exactly what it wanted for its torpedo boats have brought many benefits to the entire aviation industry. Space limitations permit touching briefly on only a few of the engineering and metallurgic high-spots.

J. G. Vincent.

In meeting the Navy's specification for a 60 per cent increase in power over our aircraft-engine rating, our biggest job was to strengthen the component parts of our marine engine to carry the heavier loads and stresses with constant regard to the weight factor. Also, we had to increase the life and stamina of the engine for the job it was to do.

To start with, the improved method of gas carburized gears, a Packard innovation, made it unnecessary to design larger and heavier gears.

Changing to stainless-steel jackets greatly increased the service life of the cylinder jackets from a corrosion standpoint.

The crankshaft was counter-weighted, dynamically balanced, and subjected to the nitriding process for greater strength. Packard was the first American manufacturer to adopt this process.

Cylinder liners were nickel and cadmium plated, then the two platings were fused to form a protective finish to eliminate corrosion and greatly increase their life—another Packard "first."

Shot blasting of connecting rods to work-harden the surface was adopted to increase their endurance limits. A change in bearings made it unnecessary to increase their size to compensate for the heavier load. The centrifugal supercharger, of the same fundamental design as used in aircraft engines, was redesigned.

Packard's early start on PT boat engine work proved of inestimable value in our other war assignment, the building of Rolls-Royce engines for American Warhawks and British Spitfires and Hurricanes. Capitalizing the lessons learned in the quantity production of high-precision marine engines of maximum power and minimum weight, we were able to swing into actual production of Rolls-Royce engines just ten months after we were selected to build them.

It seemed natural that Packard should be the one to produce this famous precision engine. Packard was awarded the Rolls-Royce contract in the fall of 1940. There were many difficult problems that had to be solved simultaneously to attain our steep production goals.

The fact that it was a British-designed engine, engineered for British materials and British methods of manufacturing, created a major problem in itself. This engine had to be built by us according to American methods of mass production. Tolerances and finishes, heretofore attained by painstaking methods, had to be done by quantity production methods.

First, a thorough study was made of the engine containing over 11,000 parts. More than 2,500 "left-handed" British blueprints had to be redrawn. British materials containing component parts not readily obtained in this country had to be respecified and yet conform to the rigid standards of both British and United States air forces. Design changes had to be worked out to accommodate American accessories. Thousands of special machine tools and tens of thousands of special gauges had to be designed and procured.

Ten months after Packard received the contract, production started. Some people have called it a "miracle." Others have described our Rolls-Royce engine production as "building fine watches by the pound." I call it the result of night-and-day efforts by a group of experienced men who knew what the job was and how to do it. We were most ably assisted, too, by British engineers and approximately 300 subcontractors who build many of the Rolls-Royce aircraft-engine parts.

* Vice-President of Engineering, Packard Aircraft Engine Division, Packard Motor Car Company.

Built to save lives!

BUILT for destruction — sure. But American planes are also built to *save* lives . . . the lives of our pilots and crews!

American planes are built with superior armor and fire power—equipped with precision instruments for every possible flight need—to take our men to objective *and bring them home again.*

Time after time, guided by instruments they fly hundreds, *thousands* of miles through pitch black night, through rain and fog and snow. They range deep into enemy territory and get *safely* back to base.

All of which adds up to one important reason why our Army and Navy Air Forces are proving more than a match for the Axis.

23 YEARS AGO
Firestone
PIONEERED
"SHIP BY TRUCK"

Today Firestone

ACROSS the wide expanse of the seven seas soar the vanguards of a new and growing fleet of planes that are as vital to Victory as bombers and fighters. Soon thousands of cargo-carrying planes will be poised on the brink of Europe, Asia, Africa and Australia, ready to carry paratroops and air-borne infantry to a vertical counter-invasion. And after they have discharged their loads of fighting men they will return again and again with tanks and jeeps, guns and supplies to keep those men fighting.

Flying on wings built by Firestone, these huge air freighters are the forerunners of a new and swifter system of peace-time transportation that will reach even to the most remote corners of the world. But building parts for these flying freighters is only one of the many ways by which Firestone is pioneering the "Ship by Air"

FIRESTONE MANUFACTURES A WIDE RANGE OF

PIONEERS "SHIP BY AIR"

movement. Bombs and bullets are also being "Shipped by Air" and delivered with devastating effect upon our enemies by planes equipped with many Firestone products.

Yes, Firestone is all-out for Victory! And from the cauterizing flames of war will emerge a swifter method of distributing the world's goods. In the not too distant future, air freight can well become as commonplace as air mail, air express and air travel. And Firestone, always a leader in all forms of transportation, will be an important factor in "Ship by Air."

☆ ☆ ☆

ARMY E NAVY

Firestone was the first Company in the rubber industry to win the coveted Army-Navy Production Award for high achievement in the production of war materials.

☆ ☆ ☆

Listen to the Voice of Firestone with Richard Crooks, Margaret Speaks and the Firestone Symphony Orchestra, under the direction of Alfred Wallenstein, Monday evenings, over N. B. C.

MATERIALS FOR THE AIRCRAFT INDUSTRY

Copyright, 1942, The Firestone Tire & Rubber Co.

CLASS 9300

AIRCRAFT CIRCUIT BREAKERS

WRITE FOR BULLETIN AC101

Class 9350 Type B4
MAGNETIC CONTACTOR

Class 9390 Type 0
THUMB SWITCH

Class 9320 Type 962
ANTENNA SWITCH

Class 9390 Type 987
MICROPHONE SWITCH

Class 9390 Type 981
LEVER SWITCH

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INVERTER RELAY

Many Types and Sizes...5 to 70 Amperes

Square D Aircraft Circuit Breakers offer "ON" and "OFF" switching and circuit protection in one small enclosure. Box and fuse wiring are eliminated. Nothing to replace. Time limit protection for small overloads, not maintained—instantaneous protection on high overloads or short circuits.

- ★ **Light weight — 2½ ounces.**
- ★ **Positive snap action.**
- ★ **Non-trip free.**
- ★ **Vibration and weather tested.**
- ★ **Trip indication.**
- ★ **Approved for military aircraft.**

AIRCRAFT *Electrical* Control DEVICES

Square D is designing and building an ever-increasing variety of equipment for the aircraft industry. Precision aircraft instruments are manufactured by the Kollsman Division—circuit breakers, gun-fire switches and similar devices by the Detroit, Milwaukee and Los Angeles plants. A few are shown in the adjacent panel.

SQUARE D COMPANY

DETROIT - MILWAUKEE - LOS ANGELES

KOLLSMAN INSTRUMENT DIVISION, ELMHURST, NEW YORK

IN CANADA: SQUARE D COMPANY CANADA LIMITED, TORONTO, ONTARIO

Air Line Contributions to National Defense

WILLIAM LITTLEWOOD*

THE AIR LINES in general and American Airlines have made their greatest contribution to national defense throughout the period of their existence in furnishing a laboratory in which have been tested, to an extent otherwise impossible, a large number of the improvements in air frames, engines, propellers, accessories, equipment and their installations, as well as the aerodynamic qualities that comprise the modern airplane.

AA alone contributes 15,000 airplane hours a month, which are a substantial addition to the proof testing and development of all features of the airplane. The list of items which have been proof tested and substantially developed under this continuous program is too comprehensive to enumerate. However, certain items stand out and are specifically mentioned here because the Engineering Department encourages such developments, arranges for the availability of trial units, maintains records of our experience, summarizes the conclusions and recommendations, and takes action to insure the inclusion of proof and desirable features in future procurement.

WHEEL AND BRAKE DEVELOPMENTS

A wide variation in tire design, materials, and construction; substantial progress in tire weight, reliability, and durability have resulted from service experience. Innumerable modifications and improvements in wheel, brake drum, brake lining and brake cylinder design and material have been service tested, with progressive improvement in these units.

DEICEING DEVELOPMENT

The air lines have conducted the first substantial service tests of the new hard alloy materials and have service tested and developed deficiencies leading to progressive improvements in steel propeller blades. The entire research and development of proper methods of fluid applications for propeller deicing was accomplished by the airlines. Various types of liquids have been tested and as a specific contribution AA conducted the first flight tests with propellers stopped in flight to determine the exact location, form, and amount of ice to be guarded against. The continuous flight testing and development of propeller governors and controls have been of great assistance to the engineers and manufacturers in achieving synchronization.

A development bearing definite military applications is that of the windshield wiper and deicer. I think we can in all due modesty claim American's sponsorship as responsible for this. We have also assisted materially in the development of the Holley F carburetor. Practically all of its features have been directly applied to the Holley H automatic carburetor, in connection with which AA has conducted most of the research development flight tests and service work. Contingent to this has been the sponsorship of the improved air scoop for use with automatic carburetion.

By means of flight research American Airlines has collaborated in the development of torque and flow meters. They have also contributed materially to improvements in deicer shoes. Notable in this regard is the provision of tear protection and refinements in boot attachment methods. Engine ice protection, as well as propeller ice protection, has also come in for its share of development by AA. Flight research under actual iceing conditions and engineering were responsible for these successful results.

Air-line experience has progressively developed numerous features of design and material to the present standard of reasonable satisfaction of deicer boots. Air-line experience has also contributed materially to design details, materials, and methods of corrosive protection for fuel tanks. Methods for adequate structural corrosion against the action of exhaust gas have also been developed.

The air lines have been practically alone in the development features of cabin and cockpit heating and ventilation which are now recognized as military necessities. Accumulative air-line experience has also resulted in a reduction of vibration as a destructive element and untold improvement in propeller, engine, accessory, cowling, engine mount, oil cooler, fuel tank, and structural failures. As for torque control of bolt and nut tightening: its development as a maintenance procedure and safety factor is based upon air-line experience.

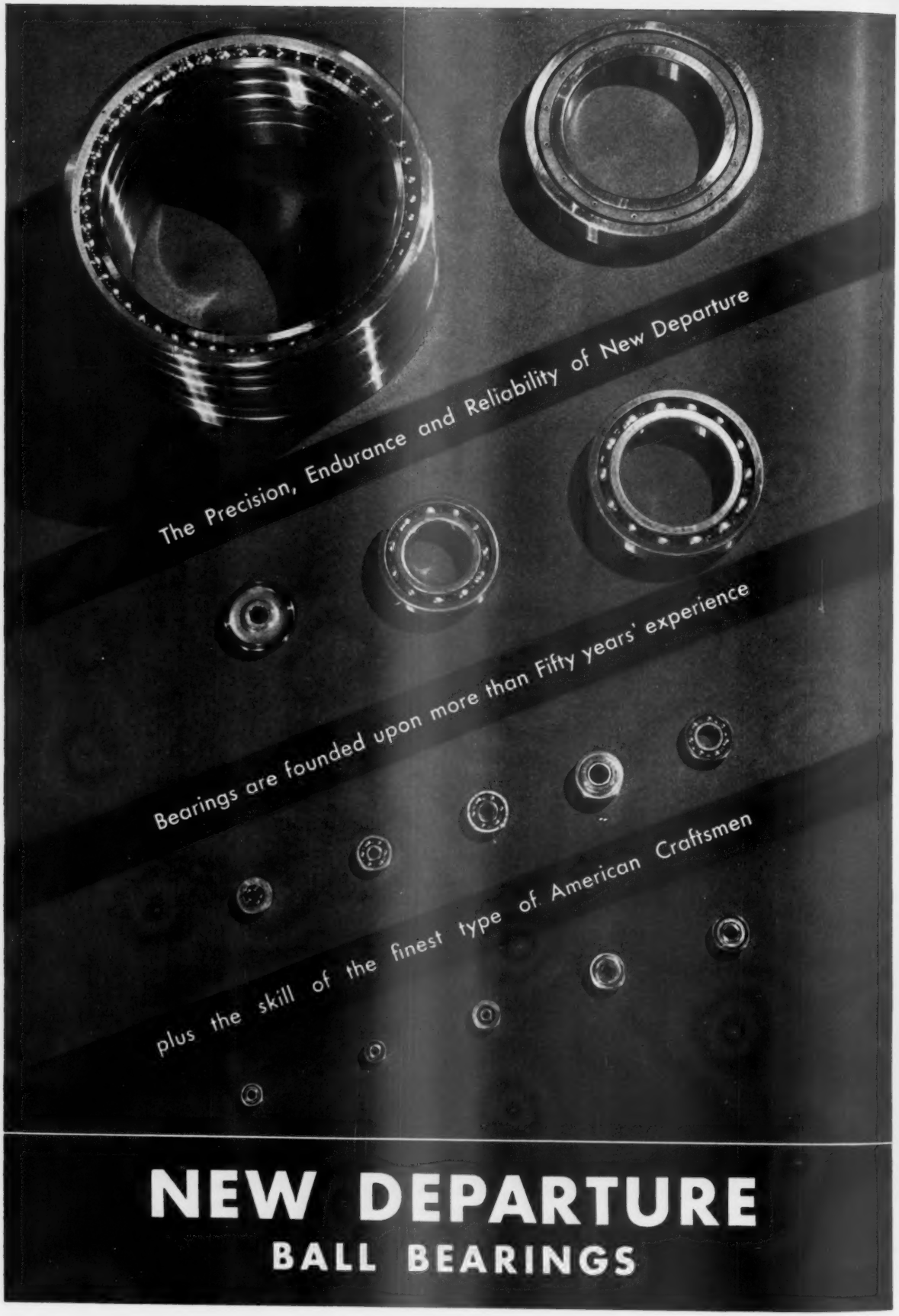
The service experience of air lines has also been active in the design and materials development of pistons and piston rings. Master rod bearings design and materials have not been excluded from their contributions nor have shock struts or oil tanks. Radical improvements in fuel tank compartment ventilation have emerged mainly at air line insistence.

As emphasized above, American Airlines has taken an important position in all these changes and improvements, the accumulative effects of which are immediately available in the interests of national defense. However, there have been specific contributions by American in which we have been alone or contributed such a large share as to justify our assuming full credit. The pitot mast deicer is among these. This simple arrangement guarantees accurate airspeed indications under iceing conditions and is also readily applicable to radio and other masts if needed. An installation providing a means for clearing water from the Pitot System developed by our efforts is the air-speed blow-out. This assures correct air-speed indications in case water has accidentally filtered into the system or after it has rained.

NAVIGATION AIDS

In addition to designing the Navigational Computer, American Airlines originated and supplied the basic principle for the Power and Performance Computer developed by Cox and Stevens. The former is in general use by the industry's pilots, the latter is understood to have received fairly wide military acceptance. In the fuel standardization field, activity by AA has been directly responsible for many improvements. Another item not to be forgotten is our contribution to propeller balancing. Collaborating with Hamilton-Standard, we provided extensive ground and flight testing and engineering consultation on the development of improved propeller balancing methods, including the development of instrumentation for this purpose.

* Vice-President in charge of Engineering, American Airlines, Inc.


The Precision, Endurance and Reliability of New Departure
Bearings are founded upon more than Fifty years' experience
plus the skill of the finest type of American Craftsmen
NEW DEPARTURE
BALL BEARINGS

Braniff Airways, Inc.

PAUL D. NILES*

FOURTEEN YEARS AGO a group of Oklahoma City business men climbed into a Stinson Detroiter and began a 116-mile flight to Tulsa. With Paul R. Braniff at the controls, thus began the original Braniff Airways. With financial backing by T. E. Braniff the B-line fleet grew and in 1929 a merger with Universal Aviation Corporation was made and Braniff Airlines, Inc., resulted. For the first time the states Oklahoma, Missouri, Kansas, and Texas were linked by air.

On November 3, 1930, the present Braniff Airways, Inc., was incorporated, headed by T. E. Braniff as its president, which post he has held since that date. Unique is the fact that Braniff Airways is the only air line in the United States bearing the name of its founder and president.

At this time the Lockheed Vegas were placed in service and Braniff Airways became known as the "fastest air line in the world." In 1935 the territory covered by Braniff Airways extended from southern Texas to Chicago which made the slogan "Great Lakes to the Gulf," still used today. Also in 1935 a fleet of Lockheed Electras was acquired, further advancing the service provided by the B-line. In 1937 a fleet of Douglas DC-2's became a part of the organization and for the first time in air-line history a Spanish-speaking air hostess was added to the flight crew.

In December, 1939, Douglas Aircraft Company delivered to Braniff Airways the first of the fleet of DC-3's or "Super-B-Liners." Jeanne Braniff Terrell was commissioned to go to the west coast factory to create interiors different from any of the other air liners in operation. Dual direction finders were added to the aircraft equipment list—an installation that had never been made in the air-line aircraft at that time.

Wright G-102A Cyclone engines powered the Super-B-Liners' engines with a 3:2 gear ratio. The Braniff installation was one of the first of this kind. The 3:2 gear ratio permits perfect dynamic balance of the propeller-engine assembly, and this means is utilized in providing a smooth ride for Braniff passengers.

One of the biggest problems in aircraft engine maintenance has been reduced fully 65 per cent by an invention of Braniff Airways' Superintendent of Maintenance, Charles Johnson. The Equal Pressure Ignition Harness System incorporating a dehydrating agent has reduced to a minimum ignition trouble resulting from moisture in the system. Many delayed schedules and interrupted flights have been saved by the functioning of this device. It is now in Government use.

During the latter part of 1940 and early 1941 air traffic became so heavy that the ordinary navigation lights were thought inadequate for the proper identification. Fin illuminating lights were designed in the Braniff Engineering Department and installed on all Braniff aircraft. This light is focused on each side of the tail fin so that its entire surface will be brightly illuminated in flight. The now well-known Ice Lights are also installed in each nacelle and focused along the leading edge of each wing so that the flight crew can keep close watch on ice formation.

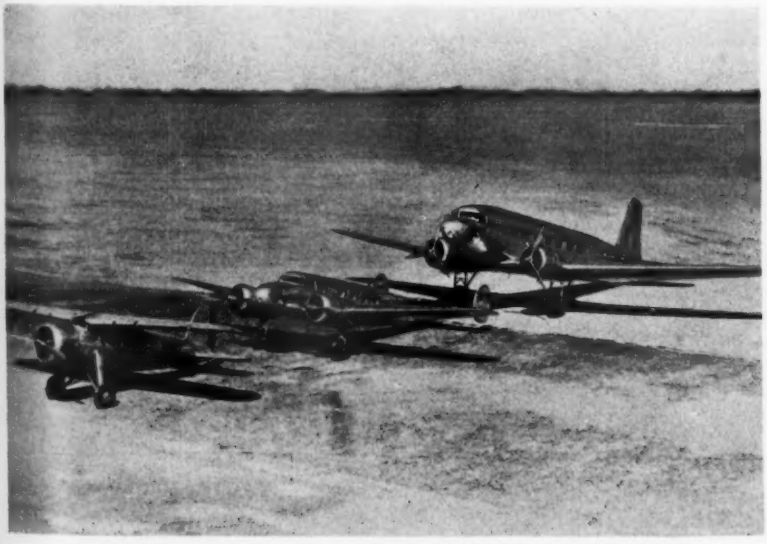
Accurate weight control has been the aim of all air-carrier operators since the time that the aviation industry became weight conscious. The weight control system set up by the Weight Control Division of the Engineering Department has been pronounced one of the best. This system has made every man of the maintenance department weight conscious, which is the determining factor in the success or failure of any weight control system.

The fleet of Douglas DC-2's became the "flyingest DC-2's ever operated" when the modern Holley carburetors were installed on them for the first time. Along with the controls for the Hydromatic Full Feathering Propellers, the engine controls were 100 per cent cable operated for the first time. Much smoother control operation and an appreciable weight saving resulted.

One of the biggest headaches in aircraft maintenance is the necessity of frequent overhaul periods in the interest of safety. The problem has been made considerably simpler by Braniff Airways' systematic arrangement of "group inspections." Rather than grounding the airplane for weeks to perform the overhaul, the various steps of the overhaul have been broken down into "groups" whereby each group inspection can be performed "between schedules." A great increase in average hours flown per day results, and in this time of aircraft shortage every minute an aircraft is available for flight helps in our war effort.

Braniff Airways, as well as the other operators, has gone to war. Air-cargo contracts have been granted to Braniff by the Government to haul valuable supplies and equipment over domestic and foreign routes. In tune with the war effort an efficient Salvage Department has been set up, resulting in a great saving of vital materials necessary in our conduct of the war.

* Assistant to Vice-President.



Three early airplanes used by Braniff Airways. At the head of the line is a single-motored, six-passenger Lockheed Vega. Next is the ten-passenger, twin-engined Lockheed Electra. At the end of the line is a 14-passenger Douglas DC-2 B-Liner, a fleet of which the line purchased in June, 1937. Braniff Airways now flies Douglas DC-3's exclusively in its passenger operations.

IN RECOGNITION OF

a truly great achievement...

Because Roebling recognizes the truly great achievement of America's aircraft engineers and production men in the designing and building of some of the world's finest aircraft, and because the engineering end of these achievements has not received sufficient attention from the public at large, Roebling advertising is setting out to tell the story in a new series of advertisements beginning this month in Time Magazine, in Aviation and in Aero Digest. The accompanying reproductions are the first of these advertisements—Roebling's salute to the industry.

Each advertisement in the series to follow will each take up the story of one of the *"names the U. S. must never forget"*, informing the reading public about some of the many difficult problems of design, specification and production that you—America's aircraft engineers and production men have met and solved.

JOHN A. ROEBLING'S SONS COMPANY
TRENTON, NEW JERSEY • Branches and Warehouses in Principal Cities

Salute
TO THE
JOB THEY'RE DOING!
No Single Part of an airplane can claim all credit for protecting a pilot's life. The ship is a roaring, pulsing structure of thousands of parts, each painstakingly engineered, each unerringly precision-built, each doing its part to protect the lives of the boys it carries, and strike hard for Victory.
That's why it takes so long to engineer an airplane, and get it into production. And that's also why our United States, with its willingness to break with tradition, its engineering skill, its vast plants and unmatched mass-production ingenuity, each developed individually and now brought together in a colossal whole, is outbuilding the enemy in air power.
LIFELINE?
We'd like to say that the Roebling Control Cord that carries the pilot's slightest touch to elevator or rudder or ailerons is the ship's life line. We can't claim that much credit. But we can—and do—think that way, as we build into it steely strength and toughness, silky flexibility. All the care and skill we've got goes into every inch of it.
JOHN A. ROEBLING'S SONS COMPANY
TRENTON, NEW JERSEY • Branches and Warehouses in Principal Cities
Names the U. S. must never forget
BEECH
BELL
BOEING
BREWSTER
COLGATE
CONSOLIDATED
CURTISS-WRIGHT
DOUGLAS
FAIRCHILD
FLEETWING
FORD
G & A AIRCRAFT
GENERAL MOTORS
GOODYEAR
GRUMMAN
HOWARD
LOCKHEED
MARTIN
McDONNELL
NORTH AMERI
NORTHRO
REPUBL
TAYLOR
THE ROEBLING DEVELOPM
...Dedicated to Vic
Trenton! Here you will find
and development laborator
include fatigue tests on control
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your service and co-opera
How to get the MO
out of Co
Salute
to the job they're doing
No Single Part of an airplane can claim all credit for protecting a pilot's life. The ship is a roaring, pulsing structure of thousands of parts, each painstakingly engineered, each unerringly precision-built, each doing its part to protect the lives of the boys it carries, and strike hard for Victory.
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John A. Roebling's Sons Company, Trenton, New Jersey. Branches and Warehouses in principal cities.
ROEBLING
means Control in the air
ROEBLING means
ROEBLING Aircraft Wires and Fittings

A Decade with Eastern Air Lines, Inc.

CHARLES FROESCH*

THE FUNDAMENTAL LAWS that govern transportation and its economic processes also apply to the airplane that is the most modern transport vehicle. Eastern Air Lines has premised its engineering policy on this fact, recognizing at the same time that safety of operation is the most important criterion for success and continued progress.

No better conception of advancement could be conveyed than that shown by the illustration, which depicts Eastern Air Lines' progress from its beginning—that is, from the "Pony Express of the Air" of 1928, which were Pitcairn Mailwings, to the present-day service offered by Douglas DC-3 airplanes.

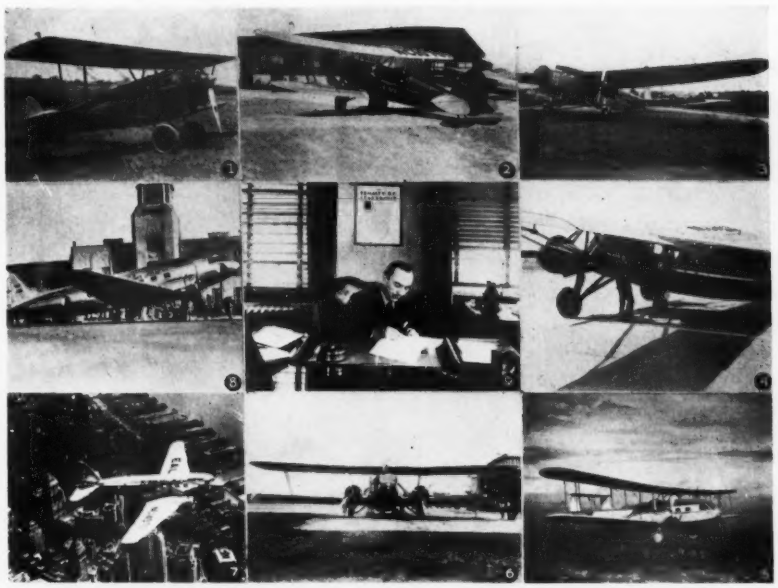
At the beginning of 1932, practically all routes flown by Eastern Air Transport, Inc., which was the predecessor company of Eastern Air Lines, Inc., had been lighted for night flying, with airports or intermediate landing fields located approximately every 30 miles.

The flying equipment operated by Eastern Air Lines ten years ago consisted of 18-passenger B-20 bimotor Curtiss-Wright Condors, seven-passenger Curtiss-Wright Kingbirds, a 14-passenger trimotor Ford, and a number of Pitcairn Mailwings for the transportation of mail only.

With this equipment, which was subsequently replaced with 15-passenger T-32 Curtiss-Wright Condors and 14-passenger Douglas DC-2's and later wholly with 21-passenger Douglas DC-3's and Douglas Silver Sleeper Transports, Eastern Air Lines established a seven-year record without any passenger fatalities, having flown over 25,000,000 miles and a total of 180,000,000 passenger-miles during that period.

Eastern Air Lines was the first air line to establish a medical department to keep its personnel constantly fit for duty. It was also the first air line to install and test an automatic pilot.

A clear picture of how the broad engineering policy of Eastern Air Lines has been applied to its daily program can be obtained by reviewing what has been done during the last ten years. First of all, and to provide service to interline cities having relatively small airports, a power-plant-airplane combination change was made on its Douglas DC-2 transport airplanes by substituting more powerful engines, which resulted in lowering the power loading without changing the wing loading,



(1) PA-5 Mailwing; (2) PA-8 Mailwing (larger than PA-6); (3) 5At Ford trimotor; (4) Kingbird; (5) B-20 Condor; (6) T-32 Condor; (7) Douglas DC-2; (8) Douglas DC-3; (9) Capt. E. V. Rickenbacker, President and General Manager.

thus obtaining improved take-off and climb performance as well as better operating safety.

A comprehensive study was made of the entire ignition system followed by numerous tests which resulted in many spark plug and ignition shielding changes. A spark plug servicing and overhaul technique was developed which reduced the maintenance and overhaul cost on this part considerably.

To eliminate, or at least substantially reduce, oil drainage at specified periods, which is an economic waste, a study was made to determine the possibility of cleaning the engine oil in flight by interposing a hydraulically operated lightweight centrifuge in the oil return line.

Similarly, and in an effort to reduce maintenance, an engine cowl flap investigation permitted a weight reduction of 54 lbs. per airplane.

On the subject of passenger convenience, Eastern Air Lines developed a center seat reading light for the Douglas DC-3 several years ago which has been made standard equipment on this type of airplane.

To provide the serving of hot food during meal hours and on relatively short flights, a service was developed which combines speed, attractiveness and low weight as well as maximum sanitation.

Eastern's engineering staff collaborated with other air lines and the Douglas Aircraft Company in the development of the DC-4 transport. Eastern Air Lines also pioneered the use of autogiros for mail carrying between suburban airports and postoffice roofs.

With the thought that effective maintenance must always be positive, methods were developed to overcome operating troubles and provide longer service life of parts. Among these may be mentioned the development of an air-speed lines blowout system, an oil cooler cleaning fixture using a special compound, and an investigation of chromium plating of wearing parts to increase their useful life.

During the last few months an investigation has been started to determine the most efficient ways and means to handle properly the transport of cargo for the military services.

While none of the technical improvements listed in this discussion are spectacular, nevertheless, each one of them has contributed its share to the safety, comfort and speed of air travel. Thus far we have gone, and with this background there is no question that air transportation must and will play a most important role in the future economic welfare of the world by providing the swiftest means of travel and communication for business and pleasure as well.

* Chief Engineer.

X MARKS spots throughout the world scheduled for attention by Brewster *Buccaneer* and *Bermuda* dive bombers designed to give the authors of Blitzkrieg an American version of aerial striking power.

BREWSTER *Blasters*

BUCCANEER AND BERMUDA DIVE BOMBERS

Mid-Continent Airlines, Inc.

E. E. JACOBS*

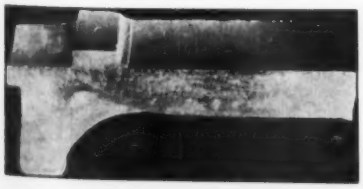
THE GREAT PLAINS ROUTE was founded as Tri-State Airlines by A. S. Hanford in Sioux City, Ia., in 1928. Its operations began by maintaining a flying school in conjunction with a schedule from Omaha to Minneapolis, via Sioux City. For a period of eight years, its routes were pioneered with Model 40-B4 Boeings, Ford Tri-Motors, Lockheed Vegas, Ryans, and a Sikorsky Amphibian.

Hanford Tri-State Airlines was incorporated on July 2, 1934, under the laws of the State of Delaware. This was occasioned by receiving under competitive bid, Air Mail Routes 16 and 26.

Route 16 originated in Chicago, and terminated in Pembina, N.D., via Milwaukee, Madison, St. Paul, Minneapolis, Fargo and Grand Forks. This route was operated for a period of six months, at which time the contract was sold to Northwest Airlines. Route 26 was operated from Kansas City to Minneapolis, via Omaha, Sioux City, and Sioux Falls, and from Sioux Falls to Bismarck via Huron and Aberdeen.

In 1936 Hanford Airlines was reorganized and became known as Mid-Continent. This year marked a trend toward more efficient and expanded operations. Its fleet of aircraft was modernized by the addition of the Lockheed 10-A type aircraft. They were operated until May, 1942, at which time they were turned over to the government for military purposes. The number of miles operated daily as of May 30, 1942 (before the reduction by the Government), was 4,738 on Route 26 and 1,888 miles on Route 48, or a total of 6,626. At the present time Route 48 is operated (1,888 miles daily) with single-engined aircraft. The reduced operations of 2,126 miles daily on Route 26 is carried out with Lockheed 18-07's. In addition to commercial mileage, our Military Transport Division operates several thousand miles daily.

* Maintenance Engineer

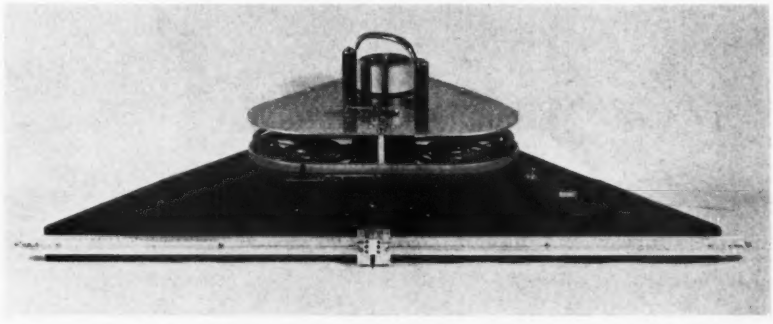


Specimen—aluminum casting weld.

RADIO DIRECTION FINDING EQUIPMENT

It was during this period that outstanding work was being done with radio direction finding equipment. The beat oscillator was adapted to DF equipment, thereby increasing the distance and accuracy of bearings. It was later adopted by other air lines and was also incorporated in the manufacturer's receivers. Dual ADF was pioneered by this company and, on the basis of their performance, they became the first air line to be granted a route over an unlighted airway.

The first three Lockheed 18-07's manufactured were placed in operation on August 17, 1940. This aircraft has proved itself efficient in every phase.



Wind simulator.

THE HAGIE-MOULDEN WIND SIMULATOR

One of the more recent developments is the Hagie-Moulden wind simulator, which is an adaptation to the Link Trainer for applying wind drift. Wind simulation is accomplished by means of a pen carriage, that corresponds to the wind velocity, which can be varied from 15 to 85 m.p.h. This self-contained unit is attached directly to the standard Link recording head with alteration. The Hagie-Moulden device is now being manufactured for moderization of the Link Trainer.

A brake disc grinder designed this year shows promise of being a great aid in the reclamation of steel brake discs. Its mechanism consists of a revolving flat disc with a centering plate that corresponds to the dimension of the brake disc. Electromagnets are spaced under the disc and so designed as to maintain the proper tension between disc and plate. The chuck is revolved counterclockwise at 80 r.p.m. by means of a two-stage reduction from a 1/4-hp. electric motor. Collector rings arranged on the shaft supply current to the magnets. The actual grinding is accomplished with a 7-in. sanding disc driven by a flexible shaft.

ALUMINUM CASTING WELDING

Because of a repeated number of failures in several types of aircraft-engine pump housings and the inability to receive replacements in time, it became necessary to experiment with the welding of aluminum castings. A jig was designed to prevent distortion due to welding. Cross-sectional specimens were prepared and etched deeply in concentrated nitric acid. Photomicrographs showed complete fusion and no evidence of high internal stress. It was found that the welded area was sounder than the parental metal. From all indications, the housing has shown a higher resistance to fatigue than before welding. During the last six months of service tests not one failure has been found.

Other projects that are well under way include the development of a suitable nonferrous inspection method, an adequate viscous-baffle type air filter for engine test stands and a revised technique in aircraft weight and balance procedures.

Inasmuch as air lines of this size are dependent upon their collaboration with the manufacturer for the majority of technical developments, it is anticipated that by means of a recent comprehensive system of data compilation it will keep abreast now as well as in the postwar period.

To summarize the foregoing paragraphs, Mid-Continent Airlines' main contribution to the aviation industry has been the operation of over 12,000,000 miles without a passenger or crew fatality.

PLEDGED to all-out aid to America's fighting forces, **NORMA-HOFFMANN** is devoting all its resources and its 31-years' experience, to the production of **PRECISION BEARINGS** for the Army, Navy and Air Corps, and for manufacturers of armament and equipment.

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U. S. A.
BALL, ROLLER AND THRUST BEARINGS • FOUNDED 1911

Pan American Airways System

WILLIAM L. VAN DUSEN*

WHEN WAR was precipitated between the United States and the Axis countries in December, 1941, Pan American Airways had had 14 years of peacetime operation to develop its equipment and flight techniques in over-ocean operation. The United States had the greatest transoceanic air-mail, express and passenger service in the world. Route mileage had been increased from 90 to almost 90,000 miles. Here will be described in brief some of the technical advancements in the last ten years which made this possible.

Successful over-ocean operation requires a progressive improvement in equipment as well as special flying techniques such as cruising control and flight crew specialization.

Flying Boat Development

By 1932, PAA driving toward the goal of commercially practical loads with adequate safety, had contracted four four-engined marine planes, known as the Sikorsky S-40, weighing 34,600 lbs. gross and with a useful load ratio of 34 per cent. Early in 1932, the Company issued specifications to manufacturers for the design and development of four-engined airplanes that would permit the establishment of a seasonal trans-atlantic service. Structural efficiencies were being improved. The Sikorsky S-42, of which the first was delivered to Pan American Airways in 1934, disproved the prevailing theory that large heavier-than-air craft were not commercially sound—that the larger the plane, the less load it would carry in proportion to its own weight. The S-42 had a gross rating of 38,000 lbs. (increased in later models to 42,000 lbs.) and a ratio of useful to gross load of 0.36 per cent, a remarkable achievement for that time. (The ratio of the well-known Douglas DC-3 short-range transport is only 33 per cent.) Equipped with extra tanks, it was used on survey flights across the Pacific and the Atlantic.

The next type of ocean transport employed was the Martin M-130. The first of these planes which, after years of service and weight accummulations, has a useful load to gross weight ratio of 43.5 was delivered in 1935.

Early in 1936, Pan American Airways contracted with the Boeing Aircraft Company for six four-engined flying boats, the Boeing type B-314, with a gross load rating of 84,000 lbs. and capable of carrying 30 passengers in berths under average conditions for 2,000 miles nonstop flight. The useful load to gross weight ratio was 40 per cent.

A Fokker F-7, the first of the Pan American Airways' transports, used on the Key West-Havana run beginning in 1927.

Before the advent of ocean flying, wing loadings on transports were in the neighborhood of 20 lbs. per sq.ft., as on the Douglas DC-2. The Sikorsky S-42 had a wing loading of 28.6 lbs. per sq.ft., and the Boeing B-314 has one of 29.4 lbs. It seems practical at the present time to develop ocean transport aircraft with a wing loading in excess of 40 lbs.

Specific Fuel Consumption

Specific fuel consumption is a function of engine design. Pan American Airways constantly has brought to the manufacturers' attention the importance of reducing the specific fuel consumption. This has been accomplished through the use of higher octane ratings and higher compression ratios. Before the advent of ocean flying, engines in use on air lines operated with specific fuel consumptions of 0.55 lb. per b.hp.-hr. using 73 octane fuel. The S-42, equipped with Pratt & Whitney Hornets, achieved a specific fuel consumption of 0.45 lb. under the conditions outlined. The Martin M-130 airplanes, equipped with Pratt & Whitney Twin Wasps, decreased this to 0.435 with 87 octane. The Boeing Model 314, equipped with Wright Cyclone 14's reduced the figure still further.

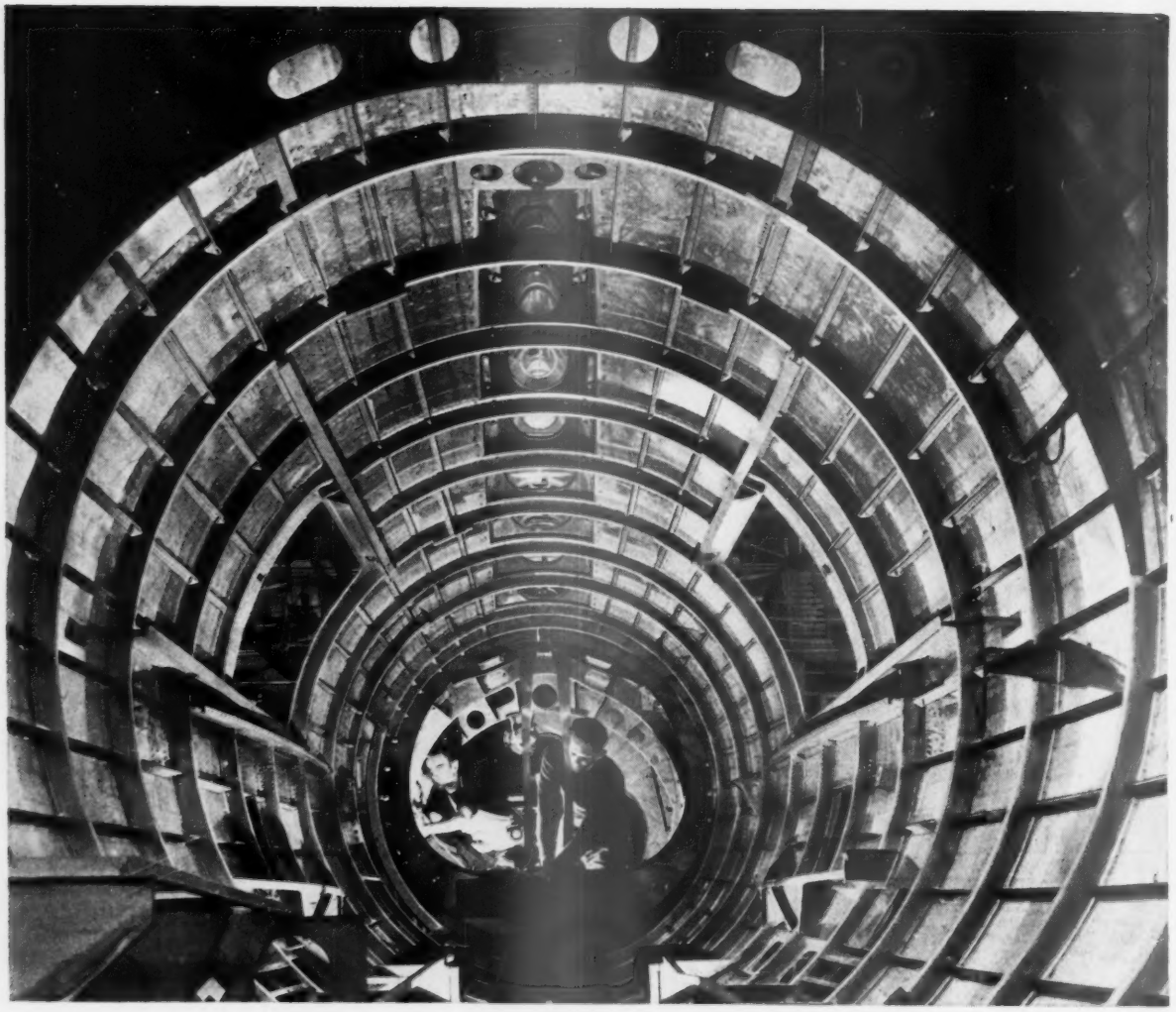
PAA Flight Conduct Curve

Also worthy of mention is the PAA Flight Conduct Curve. It was developed by the Company's ocean captains under the leadership of Capt. Harold Gray. Its purpose is to present to the crew aloft and to the flight watch ashore a continuous flow of information of the fuel reserve remaining aboard the aircraft and the fuel required for completion of the flight to its destination or back to the point of departure. Actually, it consists of five curves for the plane and its engines, showing the normal four-engined consumption for the flight in hand; the gallons versus hours of flying; the hours versus the miles; and three-engined operation for completion of the flight or return to the departure point.

The Multiple Flight Crew

The multiple flight crew is an integral part of the Pan American Airways ocean flying technique. At the inception of four-engined operation, a standard four-man crew was adopted. This consisted of a captain, a first officer, a radio operator, and an engine specialist. An analysis of ocean transport problems indicated the need for crews far larger and individually trained for specialized assignments. Growing out of that was today's standard multiple crew composed of a captain and a crew of ten. The captain, the chief administrative officer, is responsible for the aircraft, its contents, and the completion of each flight. The first officer is second in command and is the executive officer of the ship. The second officer is responsible for the navigation of the aircraft. Other personnel are: the flight engineer, the radio officer, the third officer, the fourth officer, the flight steward and assistants to the flight engineer, the radio officer, and the steward.

* Director of Public Relations.



Inside Story

You are looking straight down the barrel of a highly potent weapon—a Boeing Flying Fortress,* under construction.

Here you see the way the ribs and the stiffeners, the bulkheads and the bright aluminum skin are riveted into one compact structure.

Into a Flying Fortress go more than 30,000 different parts (counting duplicates, there are several hundred thousand separate pieces of metal). Into the design, creation and swift production of these giants of the air are riveted also many different kinds of engineering.

For example: Boeing *mechanical engineers* design the jigs—intricate, hair-true forms in which Fortress parts are assembled. . . . Boeing *tool engineers* design and adapt tools and machines to the special job of making parts in quantity production. . . . *Production engineers* find new ways to turn out better Fortresses, faster. . . . *Structural engineers* study problems of reducing weight and increasing the strength in airplane members. . . . *Aerodynamic engineers* study problems of wing, tail, propeller and overall airplane design. . . . *Power-plant engineers* work to increase the power, speed, efficiency and altitude range of the airplane.

These and still other kinds of engineering skill go into the building of a basic Boeing airplane structure. But in order to make the Fortress a swift, efficient flying work-room for nine men on a mission, other kinds of engineering are essential: *radio, chemical, hydraulic, acoustical, vibration, heating, ventilating and electrical.*

In the Boeing engineering department today, more than 2000 men are constantly at work on engineering projects. Their job is to design and help to build light metal structures of all kinds—from an airplane wing to a booster system for hydraulic brakes. And today, too, Boeing field engineers are in service wherever their Fortresses fly—in Asia, Africa, England, Australia. *Their* job is to help keep the big Boeings flying—high, fast, *and often.*

Variety in engineering skills . . . integrity in engineering design . . . economy in production . . . long experience in research . . . these are the qualities which Boeing is building into bombers, trainers and flying boats for the air forces of the Allies.

DESIGNERS OF THE FLYING FORTRESS • THE STRATOLINER • PAN AMERICAN CLIPPERS **BOEING**

*THE TERMS "FLYING FORTRESS" AND "STRATOLINER" ARE REGISTERED BOEING TRADE-MARKS

Transcontinental & Western Air, Inc.

J. C. FRANKLIN*

TRANSCONTINENTAL & WESTERN AIR, INC., has conducted an almost constant program of research and engineering development. In 1931, TWA engineers went to the Douglas Aircraft Company, Inc., carrying specifications for a new passenger plane. The result was the twin-engined Douglas DC-1, which represented radical departures from all known passenger transport standards of the early 1930's. The DC-1, original of the Douglas series that has since become world famous, was used for experimental purposes only. It was flown in exhaustive tests conducted by D. W. Tomlinson, then TWA's test pilot, and Edmund T. Allen, employed by Douglas. The tests lasted five months, from July 1 to December 1, 1933.

In it Tomlinson and Allen made the first single-engined test from Winslow, Ariz., to Albuquerque, N.M., with a full load of 17,500 lbs. A positive latch to lock the landing gear in "down" position was not part of the equipment on early flights, and Tomlinson landed the plane twice on its belly without damage, except bent propellers. These tests developed the retractable landing gear.

After Tomlinson finished his tests, the DC-1 carried 4,000 passengers on short flights to get their reaction to its comfort, quietness and luxury, which were far superior to earlier transports. The DC-1 was turned over to TWA in December, 1933.

The DC-2 was evolved as the first production model, TWA receiving the first, which was known as No. 301. Some 20 in. longer than the DC-1, it had a passenger capacity of 14 instead of the 12-passenger arrangement of the DC-1. TWA took formal delivery of the first DC-2 on May 14, 1934. It served with TWA's fleet until last year when it was turned over to Great Britain for overseas service.

It was during this period that TWA embarked on its extensive program of research and engineering development which gave the company the distinction of many "firsts" in aeronautical advancements. Among them were the following:

1931–1932—Original specifications for the modern Douglas planes—now used by most of the air lines, were written by TWA.

1932—TWA, in cooperation with the Goodrich Rubber Company, pioneered the development of the deicer.

1934—TWA was the first commercial air line to adopt the Sperry Automatic Pilot as standard equipment on its fleet, the first in America to adopt the use of wing flaps or "air brakes" to reduce the landing speed of planes, and the first to inaugurate successful steam-heated cabin planes to insure passenger comfort and to eliminate the hazard of carbon monoxide present in the then existing heating systems. It was first to develop the electrical engine synchronization indicator and first to develop and use the slinger ring propeller deicers.

1936—First to develop and use the antirain static homing radio direction finder.

1939—TWA was first domestic air line to equip its planes successfully

J. C. Franklin.

with broadcast radio receivers for passengers.

1940—The first domestic air line to use four-engined equipment on regular passenger schedules since a predecessor company, Western Air Express, instituted service for a short period in 1930–1931 with four-engine Fokker F-32's. In the same year the company pioneered in "over-weather" flying at high altitudes, which resulted in the development of the Boeing Stratoliner, the first supercharged cabin transport to be placed in domestic air-line service. TWA in 1940 also was the first domestic air line to train pilots in celestial navigation.

1941—The high-speed supertransport, the Lockheed Constellation, capable of bringing any capital in the western hemisphere within 16½ hours of the United States, was conceived by Howard Hughes and Jack Frye, president of TWA. Initial specifications of this plane, originally built for TWA, called for accommodations for 57 passengers and a crew of seven.

TWA launched its research program with the DC-1. One of its early achievements was the breaking of the transcontinental speed record for transport planes. It flew nonstop from Burbank, Calif., to New York in 11 hours and 5 min.

Next came load carrying and other speed tests around a triangular course on the east coast. In two days of flying, eleven national and eight international records fell.

High-altitude experiments started with the DC-1, too. Special equipment was installed on the plane, and flights were made over and through thunderstorms to obtain information concerning conditions to be encountered at altitudes up to 29,000 ft. In the course of the experimental flights, an oxygen system was installed for the high altitude trips.

The DC-1 then was flown approximately 20 hours at altitudes averaging 22,000 ft. In the course of these experiments, it was found that the plane could clear 95 per cent of the cloud formations when cruising at 20,000 ft.

To complete the high-altitude research, TWA in 1936 equipped a single-engined Northrop Gamma mail plane with a turbosupercharger which was borrowed from the Army Air Corps. This plane had a higher ceiling than the DC-1 and it was possible to observe weather conditions up to 36,000 ft.

Following these experiments came the fleet of Boeing Stratoliners, the next major advancement. For 18 months, beginning July 8, 1940, TWA operated five of the Stratoliners in domestic service. These 33-passenger four-engined transports were equipped with pressurized cabins in which atmospheric pressure was controlled in such a manner that passengers could enjoy low-altitude comfort while flying up to 20,000 ft.

Since late last winter, the Stratoliners have been operated for the Army in foreign service, but their stay in domestic air-line service was long enough to prove the popularity of "over-weather" high-altitude flying with the traveling public.

TWA continues active in its development work, but progress on many of the projects comes under the heading of restricted information.

* Superintendent of Engineering.

PIONEERING TO MEET TOMORROW'S NEEDS

At Kitty Hawk in 1903—Everywhere Today . . .
Socony-Vacuum Keeps Pace With Aviation

RIGHT FROM THE START—ever since its products helped the Wright brothers complete the world's first successful airplane flight . . .

Socony-Vacuum has met Aviation's ever-changing needs with dependable fuels and lubricants.

Its long experience in serving Aviation—unmatched by any other petroleum company—enables it to keep constantly ahead of Aviation's problems . . . to help solve them with pioneering research and the most modern refining methods.

That's why both private and commercial operators throughout the U. S. A. rely on Socony-Vacuum products for safe, efficient, economical performance.

SOCONY-VACUUM OIL COMPANY
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Magnolia Petroleum Company • General Petroleum Corporation of California

Allegheny Ludlum Steel Corporation

C. A. SCHARSCHU*

THE ALLEGHENY LUDLUM STEEL CORPORATION has always been primarily a producer of special and high-quality steels and its experience in this field has enabled it to make a number of important contributions to the airplane industry.

STAINLESS STEELS

In 1925, Allegheny pioneered the development in this country of stainless steels of the 18 per cent chromium-8 per cent nickel type. These austenitic stainless steels have found widest use in the aeronautical industry because of their ductility, toughness, and strength at elevated temperatures, in addition to the normally expected corrosion resistance. The range of compositions from 17 to 20 per cent chromium and 6 to 10 per cent nickel comprises the range of compositions usually referred to as austenitic stainless steels. Within this stated composition alloys of widely different types of mechanical properties can be obtained. These vary from material with a high rate of work-hardening, which can be cold-rolled into high-tensile sheets or strip with sufficient ductility to alloy the material to be formed into structural shapes, to alloys with a low rate of work-hardening that lend themselves readily to spinning and forming operations. The commercial classifications of these grades of stainless steels do not take this variation in mechanical properties with composition into account and therefore, where specific compositions are necessary in order to obtain desired results, restricted composition under a given type must be used. Grades of stainless steel best suited for cold-rolled high-tensile strip, as well as for deep drawing and still other grades for spinning, have been developed. In order that the composition best suited for various applications can be supplied to users, different grades are now made under what may be considered one type of stainless steel according to commercial classifications.

Where service conditions require heating of the metal into the range of temperatures around 1,200°F. and subsequent contact with corrosive conditions at room temperature, austenitic stainless steels containing columbium or titanium are available.

SHEET AND STRIP

In the field of high-tensile cold-rolled sheet and strip, compositions have been developed that can be cold-rolled to a sufficiently high strength to exceed the strength-weight ratio of aluminum alloys and still have sufficient ductility to allow themselves to be formed into various structural members.

WIRE DEVELOPMENTS

It has been just a little over a decade since 18–8 stainless wire was first used in the manufacture of control cords. Allegheny Ludlum was the pioneer producer of the wire for this purpose.

The wires used in the construction of these cables or cords run from 0.007 in. diameter up to 0.016 in. diameter and average 315,000 lbs. per sq.in. tensile strength. During the first several years of manufacture, it was difficult to make wires that would give consistent and satisfactory life when the finished cord was given a fatigue test. Research has enabled us to develop methods of manufacture so that high and consistent fatigue values are always obtained by the wire rope fabricator.

The development of the proper stainless wire or bar used in the fabrication of tie rods is another Allegheny Ludlum achievement. The oval section streamline rods are cold-worked to shape from round bars. The physical requirements of the finished tie rods are such that these bars must be of the highest physical quality when furnished to the tie-rod fabricator.

Another well-known use of these bars is in the production of aircraft cable terminals and turnbuckle parts. The type of steel used is a free-machining 18–8 and is processed to give maximum ductility so that these fittings can be swaged tightly onto cables without any risk of cracks that might cause failure during use.

Stainless bars and wire are used in the production of numerous other parts that go into assembly of aircraft. These parts include safety wire, hinge pins, rivets, screws, bolts, nuts, springs, shafts, and high-tension ignition cable.

ENGINE STEELS

Since engines of modern aircraft use essentially the same steels for exhaust and intake valves as were common ten or more years ago, it might seem that little has been contributed to this phase of aeronautical development. Allegheny Ludlum, however, has made one significant addition to the steels available for aero intake valves and also important improvements in the quality of existing steels.

This steel is hardenable to at least 50 Rockwell "C" and retains hardness well on tempering. Originally developed as a hardenable, corrosion-resisting automotive exhaust valve steel, it has recently been found to be a satisfactory substitute for other steels containing strategic metals commonly used for intake valves.

The ever increasing loads imposed upon aircraft valves have resulted in more stringent standards of quality inspection, including the Magnaflux test when applicable. Unremitting effort has established for Allegheny Ludlum an enviable reputation for high-quality valve steel among aircraft valve makers.

The adaptation of the airplane to extremely high altitudes has necessitated the use of turbocompressors or superchargers in order to supply the necessary air for operation of the engine. To insure greatest efficiency, these devices operate at extremely high temperatures, and steels with strength greater than that possessed by our best high-temperature steels are required. Allegheny Ludlum has aided materially in the manufacture of these steels and has also developed two new steels that not only conserve vital metals but are stronger than steels now in use for this purpose.

A vital part of the combat plane is its armor plate and both homogeneous and face-hardened types are used. The Pluramelt process, developed by Allegheny Ludlum Steel Corporation, is an ideal process for producing face-hardened type, and a large amount of plate made by this process has been supplied.

It has been extremely difficult to make consistently steels with satisfactory welding qualities for the production of the welded airplane propeller. Allegheny Ludlum by using methods previously developed has been able to produce consistently steels satisfactorily for this purpose.

Other contributions that might be briefly mentioned are the development of tool steels of the molybdenum type used for machining airplane parts, the development in this country of the nitriding process now used for hardening valve stems, the production of special steels for nitriding, and the development of special grades of magnetic steels which are used in some of the airplane accessories.

* Director of Research.

SCOURGE of the PACIFIC

Wake Island . . . Coral Sea . . . Midway . . . the Solomons . . . whenever and wherever Tojo thrusts his task forces or transports . . . Grumman Wildcats and Avengers play an important part in wrecking his plans.

The success of F4F's and TBF's is not a matter of chance. Sea duty and deck landings demand the structural "guts" and precision performance that Grumman builds into *every* plane . . . characteristics born of long experience in designing and building aircraft for specific services.

These rugged Grumman planes are the scourge of the Pacific because they're built for the job . . . are doing it so effectively because of the skill and energy and daring of the lads who man them!

Wildcats & Avengers

Grumman Aircraft Engineering Corporation · Bethpage · Long Island · New York

Bendix Aviation Corporation

CHARLES MARCUS*

Air frame, power plant and accessories—in each field major improvements in design and processing have contributed to the leadership established by American aircraft during the past ten years. Bendix Aviation Corporation as the largest manufacturer of aircraft accessories has kept pace with the air-frame and power-plant groups in forward thinking and production ingenuity.

The diversified nature of the Bendix business in aviation is noteworthy including, as it does, starting, stopping, controling, igniting, metering, communicating, detecting, piloting, navigating, indicating, directing, pumping, shooting, landing and many other interests. The devices which Bendix makes to do these jobs are unique in their compactness, lightness and precision of manufacture.

As aircraft engines grew in size, the amount of energy required to turn them over increased in proportion. For this bigger job, electric starters have been evolved which combine the best features of the inertia and direct cranking units, and cartridge starters have been developed for the special demands of naval aircraft.

With the larger aircraft and more powerful engines came increased demands for electrical power and, in order to give better service, this increased power had to be delivered at a more constant voltage. Generator design has been improved to the extent that eight times more power is delivered for the same weight, and novel compact carbon pile regulators provide considerably improved voltage control.

Eclipse Aviation Division

Deicers, pumps, valves and oil separators also developed during this period by Eclipse Aviation Division have added a substantial element of safety to all weather flights. Propeller pitch controls, automatic engine controls, power actuators, hydraulic pressure pumps and electric motors for the operation of retracting mechanisms, flaps and tabs are among other Eclipse Division contributions.

A program of research on carburetion has resulted in an entirely new system of handling fuel and air which combines the features of direct fuel injection with an improved Venturi tube method of air metering. This has made possible the continuous injection of metered gasoline under pressure at any desired point in the air intake system, and the operation is now free from the limitations of the old float type chamber. The hitherto unapproached accuracy of mixture control is maintained by automatic correction for altitude and temperature changes.

Scintilla Magneto Division

Engineers of the Scintilla Magneto Division, working closely with engine manufacturers, have created new magnetos, spark plugs, switches and harnesses in step with the requirements of high-altitude and high-horsepower operation. Of particular importance have been the supercharged ignition system, the low-tension ignition system and filled harness.

Pioneer Instrument Division

Interesting navigational aids have come from the Pioneer Instrument Division of Bendix Aviation Corporation. Among these is a remote reading compass, designated the Magnesyn, which is of simple construction and light in weight. The transmitter of this device is an ingenious magnetic pickup element mounted adjacent to an ordinary card and float type magnetic compass and feeds into from one to three indicators without any amplification of power. Pioneer research effort has also produced a basically new compass consisting of an inductor element stabilized horizontally by an electric gyro that combines in one device the directivity of the magnetic compass and the stability of the gyroscope.

Another Pioneer instrument is a drift meter with gyro-stabilized reticle representing a real aid in the calculation of drift. Miniature self-synchronous generators and motors adaptable to almost every remote indicating function on an aircraft are among the most useful contributions of Pioneer research to practical problems of airplane construction and control. These units are employed in all manner of control functions and in instruments where small amounts of synchronized torque-producing elements are necessary.

The automatic radio compass, result of seven years of research, provides a continuous visual indication of the direction of a radio station.

Julian P. Friez Division

Something has been done about the weather, too, by the Friez Division, which produces a balloon-carried miniature weather station-radio transmitter called the Radio Sonde for upper air analysis. This transmits speedy and accurate information to the weather observer which, when combined with information from Friez airport instruments, assists in the forecasts so vital to flight operations.

Bendix Products Division

The development of airplane wheels, brakes and struts has a story of its own in the progress of aviation in recent years. The original drop rig for the testing of struts had a maximum capacity of 5,000 lbs. Recently, the Bendix Products Division tested a strut under a static load of 50,000 lbs. and the present drop-test rig is capable of taking struts designed for loads up to 200,000 lbs. The giant B-19 bomber rolls on 96-in. wheels built by Bendix and equipped with duo service hydraulic brakes of full floating design—by far the largest wheels and brakes ever built for aircraft use.

Bendix equipment and accessories cover the whole range of aviation from weather to wheels, from supercharging to vacuum pumps, from the oldest of arts to the newest of sciences. Never in the history of the corporation has its accomplishment been so great or its investigation into the future so vigorous.

Charles Marcus.

* Vice-President in charge of Engineering.

Reprinted from
AUTOMOBILE TOPICS
March 3, 1918
Our Present and Immediate Task
is to maintain the supremacy of the air—aeroplanes for ourselves and our Allies must be turned out at top speed.
WYMAN-GORDON
Aeroplane
Crankshafts
are doing their share in making Perfect, Safe and Sure the driving power of these aerial scouts of the army.
All the artistry and every device of the Master Forger, developed in over a third of a century making crankshafts for Automobile and other high speed engines, is concentrated in the production of these vital
This advertisement (left) published nearly a quarter of a century ago is as true today as when it appeared. Wyman-Gordon's production was then as now, all for war. Vital forgings, then and now. Two hundred eighty-four Wyman-Gordon forgings in this B–24 bomber, every one laboratory controlled from bar steel to finished product.
WYMAN-GORDON
Guaranteed Forgings
WORCESTER, MASS.
HARVEY, ILL.
DETROIT, MICH.

The BG Corporation

C. B. BUNCH*

SINCE the introduction of BG Aviation Spark Plugs during World War I, great advances have been made in aircraft engines as well as the aircraft itself. Throughout this period of development BG has kept pace with the demands. During the past ten years, The BG Corporation has pioneered many ideas in connection with aircraft spark plugs and their service. The technical staff of electrical and mechanical, as well as physical and chemical, engineers has been greatly enlarged to cope with the many and various problems associated with ignition systems.

The general design of BG aircraft-type spark plugs presently incorporates the use of high-grade mica as insulation for the high voltages that are required. To increase the plug's service life, which is measured by the rate of electrode erosion, the use of multiple-ground electrodes has superseded the single-ground electrode used on earlier spark-plug models. Suitable combinations of electrode materials have also decreased the rate of erosion. Engineering investigations over extended periods of time have assisted in the development of spark plugs to operate over a wide range of conditions. The most outstanding example of such a spark plug is the 417-S, which is suitable for aircraft engines having from 65 to 800 hp. For higher output engines, the Model LS465 has been highly successful.

Undergoing tests at the present time is a recently designed spark plug incorporating the use of a resistor, which has been found to further decrease the rate of electrode erosion. Results up to the present time have been encouraging, and work will continue on this project.

* Service Manager.

To eliminate troubles frequently experienced with spark-plug terminal sleeves, a new type ceramic sleeve has been offered to replace the impregnated paper-base types that have been used up to the present time. The ceramic sleeves are nonwater-absorbent. Permanent flashover tracks, which are so undesirable, will not form.

In the field of test equipment, The BG Corporation has introduced to the industry two units that are now in wide use. The first is a Spark Plug Test Set. This instrument was designed for checking spark plugs to determine whether they are in a satisfactory electrical condition. The electrical circuit includes a high-voltage bridge, in one leg of which are incorporated the spark plug under test and the pressure chamber. By quenching the spark with high-pressure air or gas in the pressure chamber, a predetermined potential can be applied across the insulation of the spark plug. If an electrical leak occurs, it is indicated by the glow of a neon bulb. No glow indicates a good plug. With this test, therefore, it is possible to quickly establish whether or not the insulation of the spark plug is electrically secure. If it is secure, a spark can occur between the electrodes of the spark plug in the presence of engine operating pressures when the gaps are within the limits of 0.010 to 0.030 in.

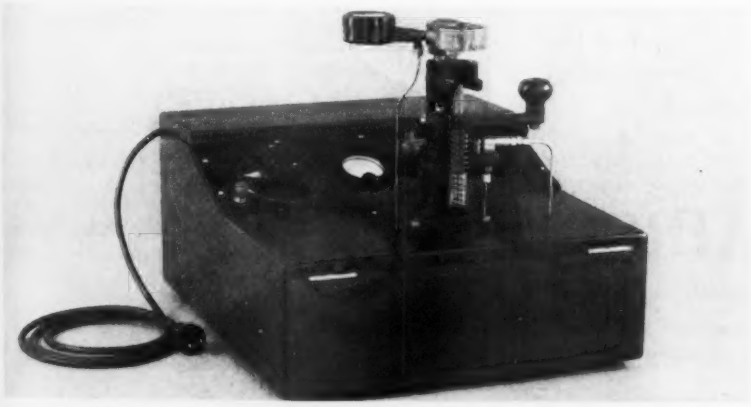
The second instrument is an Ignition Harness Test Set, which was designed to check ignition harnesses to determine whether the wire insulation, terminal sleeves, etc., are in a satisfactory condition. It operates from standard a.c. sources of voltage and, by means of a transformer, permits the application of a high potential across the insulation of the wire (from the conductor to the radio shielding). With this instrument the source of trouble can be quickly, easily, and accurately located.

BG Ignition Harness Test Set.

For the purpose of providing educational information on the proper methods of servicing and handling aircraft spark plugs, The BG Corporation produced a sound film entitled *Spark Plugs in Aviation*. It is a 16-mm. sound-on-track film, is 1,200 ft. long (equivalent to 3,000 ft., 35-mm.), and requires 30 min. for showing. By animation and narration, the complete process of servicing spark plugs is indicated. Included also are the theory and operation of the ignition harness test set demonstrating the method of locating some of the more common sources of trouble that are sometimes attributed to faulty spark plugs. The film has been made available to schools and institutions for showings free of charge.

Toward the end of developing a complete ignition system, there are currently under way projects on a flexible ignition harness as well as a magneto. The ignition harness has progressed to the stage of extensive field service tests. Also in the development stage is a ceramic spark-plug project, and several models are currently on test.

It is intended that the progress which has already been made by The BG Corporation will continue, with the view that future developments will contribute to the further development of aviation.



M591 Spark-Plug Test Set.

COME ON, LET'S DO MORE! WE'RE FIGHTING A TOTAL WAR!

"SLOGAN OF THE MONTH" by Norcrafter Glen Briggs, Dept. 6

TEN HONORABLE MENTIONS OF THE MONTH

"Let us see to it the Japs don't do it." by Dick Mickle, Dept. 6

"Completed planes give Axis pains." by W. F. Schneider, Dept. 18

"Save your scrap to lick the Jap." by Seymour Block, Dept. 52

"Let's change Hitler's creed by Northrop's speed." by Don Roberts, Dept. 25

"Every bomb in the rack is a Jap in the sack!" by R. E. Tobiason, Dept. 52

"If we work as a team, we'll stay on the beam." by W. L. Kilgore, Dept. 50

"Let's give it the gun, 'til the job is done." by Bud Southwick, Dept. 43

"It's what you do today, not tomorrow, that counts." by Don G. McCarthy, Dept. 8

"Shall we get behind victory or, just get behind?" by William Chandler, Dept. 5

"Build those planes, make that dough, loan it to Uncle Sam, and just watch him go." by R. W. Cowdery, Dept. 3

Sentiments like these *by Northrop people* are speeding our production progress

The "Slogans of the Month" posted about our plant are something visitors almost invariably praise. We are proud of them, too, for every one is the creation of the men and women *who are doing the job at Northrop.*

Since the month of April, more than 1200 such slogans have been turned over to our War Production Drive Committee. Norcrafters from virtually every department in the plant have submitted slogans. It has been a lot of fun. But more important, it has had a very real effect in stimulating us all to "*DO MORE.*"

NORTHROP AIRCRAFT, *Inc.*

Northrop Field, Hawthorne, California

MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.

Some Recent Contributions of the Chemical Industry to Aviation

JAS. K. HUNT*

ADVANCES IN AVIATION during recent years afford an excellent illustration of teamwork between the engineer, metallurgist and chemist. To the metallurgist, credit must be given for developing the improved alloys—both steel and light metal—which today enter so prominently into aeronautical construction. Of no less importance, though sometimes working behind the scenes, are the contributions made by the chemist.

Typical of recent contributions by the chemical industry to aeronautics are certain Du Pont developments, but it should be emphasized that this company is only one of many which have contributed importantly to advances in aviation.

One important contribution of the chemical industry which operates well behind the scenes in the aviation industry is the use of nonflammable chlorinated hydrocarbon solvents for degreasing of machined metal parts used in airplane construction. The cleansing action of these solvents allows more efficient inspection, increased precision in manufacture and, indirectly, greater speed of production.

Another outstanding chemical contribution is the development of transparent acrylic resins, said by some aeronautical engineers to be the plastics industry's greatest single contribution to aviation. But plastics other than methyl methacrylate find application in aviation. Transparent sheets of cellulose acetate are used as enclosures for gliders and military training planes, and polyvinyl acetal sheets are used as the interlayer in the safety glass for some windows and other transparent sections.

Polyvinyl alcohol (PVA) plastics represent another recent chemical contribution to aviation. Because it is unaffected by oils, gasoline and vibration, "Resistoflex" PVA tubing is being used on planes for fuel and oil lines. Because it is free from odor and highly impervious to oxygen, PVA is also used for special pilots' equipment.

Synthetic rubbers are finding important applications in aviation, not so much as simple substitutes for rubber but rather because of special characteristics not possessed by natural rubber. The superior sunlight resistance of neoprene makes it useful as the veneer of deicers on airplane wings. Again because of sunlight resistance, neoprene is the only material now available which can be used successfully for impregnating the fabrics used for barrage balloons and blimps. Neoprene has also been used experimentally and successfully in tires for aircraft, where resistance to deterioration by oils and sunlight must be considered.

Barrage balloons are made from neoprene impregnated fabrics because of the resistance of this synthetic rubber to the effects of sunlight.

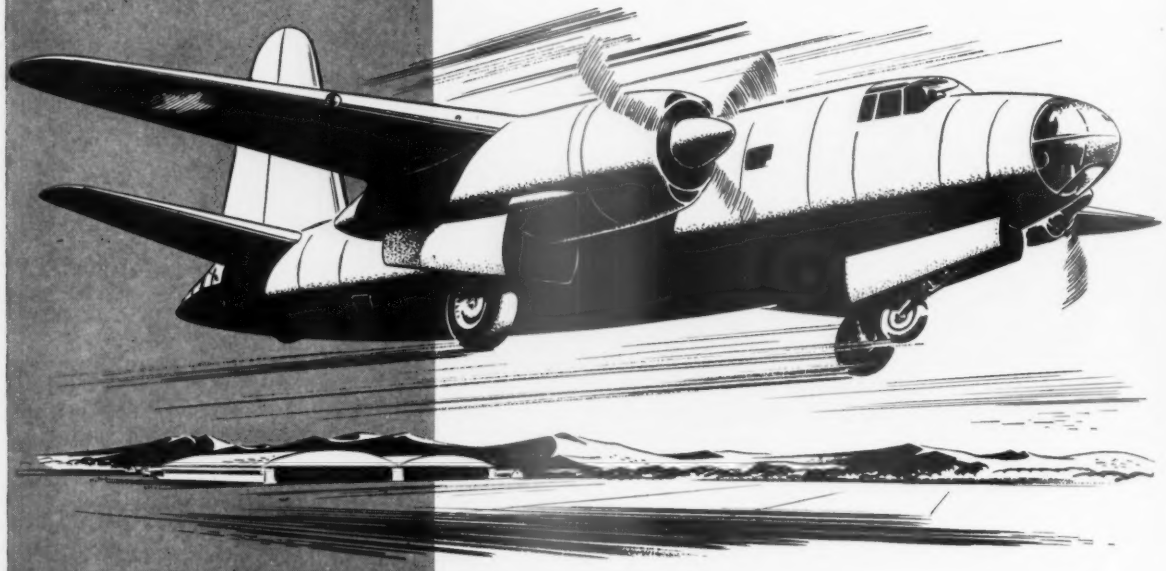
Because of its resistance to oils, neoprene likewise finds numerous aviation uses. Upside-down flying is facilitated and made safer through the use of a neoprene-impregnated diaphragm that avoids the use of floats and greatly simplifies carburetor construction. Neoprene couplings for magneto drive gears are resilient, oilproof and shockproof. Dozens of other aviation uses might be cited for this synthetic rubber, including hose, gaskets, cable insulation, and caulking cements.

Special finishes have also been developed for airplanes, including an alkyd type related to the "Dulux" synthetic resin finish widely used on refrigerators. An important, although unsuspected, quality of this new finish was revealed with the discovery that it withstands the destructive action of deicing fluids, a property that the previously employed lacquer finishes did not possess.

Space limitations permit only brief mention of other important chemical contributions to aviation: zinc chromate primers for steel and the new aluminum alloys; putties resistant to cold cracking, to improve the aerodynamic efficiency of wings by reducing the drag caused by seams and depressions; flameproof, water-repellent and mildew-resistant finishes for certain of the textiles used on both civilian and military planes; high-tenacity rayon for the tire cord of military planes; nylon yarn for parachutes; improved electroplating processes that facilitate the selective carburizing or nitriding of steel parts; techniques for the electrodeposition of heavy coats of silver, overlaid with lead and indium, for engine bearings; explosive rivets that, because they can be set rapidly where only one surface is accessible, have speeded up plane production and field repairs; and improved adhesives. Dozens of others might be mentioned, such as improved lubricants, high-octane gasoline that gives tremendous speed and power to our fighting planes, etc. While Du Pont has been working with the aeronautical industry and the Army and Navy Air Corps in the development and application of new materials and new techniques, other representatives of America's unparalleled chemical industry have been similarly engaged. Du Pont's contribution is merely typical. In part as a result of this close cooperation between chemistry and aeronautics, America today has unquestionably the greatest aviation potential in the world.

*E. I. du Pont de Nemours & Company.

On the job . . .
at every take-off



From the list of Simmonds engineered aviation accessories, the following are in wartime production for the fighting forces.

Simmonds-Corsey
FLEXIBLE PUSH-PULL CONTROLS

CHRONOMETRIC RADIOSONDES

Simmonds-Benton
SPARK PLUGS

Simmonds-Olaer
HYDRAULIC ACCUMULATORS

Simmonds-Hobson
INDUCTION PRESSURE (BOOST) CONTROLS

Simmonds-Prentice
ROD ENDS

Simmonds type
COWLING AND PANEL FASTENERS

TA CLIPS AND RINGS

QUICK DISCONNECT UNITS

AN ever growing number of America's hard-hitting fighting planes are equipped for efficient performance with Simmonds products. One or more items from the list of Simmonds aviation accessories is in action on world-wide fighting fronts with every American bomber in the air today.

Simmonds is proud that all its manufacturing experience and facilities are enlisted in the battle for Freedom. It takes pride, too, in the increased demands for the high quality, performance-proved products which it manufactures in quantity. Until Victory is ours, Simmonds precision-made parts will be "on the job at every take-off".

SIMMONDS AEROCESSORIES INC.

10 ROCKEFELLER PLAZA, NEW YORK, N. Y.

Mutual Home Building, Dayton, Ohio • 6253 Hollywood Blvd., Hollywood, Calif.

Freedman-Burnham Engineering Corporation

WALTER E. BURNHAM*

THE AVIATION manufacturing companies prior to Pearl Harbor might well be called, generally, the pioneering companies, although the words "research" and "development" might be used instead of "pioneering." It is a fairly accurate statement to say that all the current research, development *and* production would not be possible if it were not for the so-called "pioneering" companies prior to Pearl Harbor.

In the early days of aviation a propeller was a device approximately in the form of a wooden screw which was installed on an airplane to provide thrust. The efficiency was low but quite satisfactory when used on the generally inefficient and slow airplanes of the time. As the design of the airplane improved and the demand increased for improved performance, this primitive propeller was not adequate for the job. The first step toward improvement was to separate the blades and make them adjustable. As further increase in performance was demanded and with the advent of the supercharged engine, it became necessary not only to be able to adjust the propeller on the ground but also to control it while in flight.

DESIGN REFINEMENTS

While many attempts were made to accomplish these refinements in propeller design, using wood as a structural medium for the propeller, none was entirely successful and metal was finally universally adopted.

Because of the increased weight and cost of these metal propellers, they were not adaptable for use on low horsepower airplanes. As a consequence, a low horsepower or so-called light airplane was forced to use the conventional outmoded fixed-pitch wood propeller. In order to properly fit each individual engine, it was necessary for the airplane manufacturer to stock propellers for several degrees of pitch. Furthermore, the propeller manufacturer was required to manufacture various degrees of pitch in the same model propeller. All of this obviously required additional stock space on the part of the distributor.

In order to meet the demand for a more efficient propeller and a propeller comparable to the conventional metal adjustable pitch propeller, the Freedman-Burnham Engineering Corporation conceived and developed an idea of a wooden adjustable pitch propeller for light planes.

Walter E. Burnham.

HUB DEVELOPMENTS

Obviously the propeller must be of a separate blade type in order to be adjustable. The fact that the propeller is severed at the hub introduced a complication of carrying the centrifugal force through some kind of a fitting between the hub and the blade. Furthermore, if wood is to be used for the blade section, it is necessary to make a joint between the metal hub and the wood blade. Natural swelling tendencies of wood when subjected to atmospheric changes could not be tolerated at this connection point. Therefore, it is necessary to develop some means of stabilizing the wood material at least at the blade shank in such a way that changes in dimension would not be sufficient to allow the blade to become loose in the hub. However, it is not desirable to increase the weight of the blade appreciably. The Freedman-Burnham Engineering Corporation developed a method of treating the shank portion only of a continuous laminated wood blade in such a way that it could be fitted into a circular metal hub socket without these difficulties. The process thus developed is roughly as follows:

The wood laminations are planed to a thickness of between $^1/_2$ and 1 in., band sawed to the approximate contour, and glued together in a propeller block similar to the process used in conventional fixed-pitch wood propellers, except that the blocks are for separate blades instead of a continuous propeller. These blocks are carved to within approximately ten thousandths of an inch of the finished contour of the blade on a carving machine which was especially developed by the Freedman-Burnham Engineering Corporation. The shank portion is then impregnated with a phenolic resin. This impregnation penetrates the shank end of the propeller in the form of a shell approximately 1 in. thick measured from the exposed surface which makes contact with the propeller hub. After impregnation, a metal sleeve is swaged over the wood. This sleeve is turned to the correct dimension of the finished propeller shank. A curing process follows this swaging operation which polymerizes the resin which has been impregnated into the wood shank. This treatment effectively seals the shank end of the wood propeller against atmospheric effects.

MOISTURE PROBLEMS

It has been found that moisture is absorbed into wood in the ratio of approximately 85 to 90 per cent through the end grain and from 10 to 15 per cent through the side grain. The end grain has been effectively sealed by the previous treatment. Entrance of moisture through the side grain is prevented by a treatment of synthetic enamel applied over the outer surface of the blade. Comprehensive tests of alternate exposure to 100 per cent moisture and oven dry conditions prove that this treatment effectively stabilizes the entire blade, preventing not only changes in dimensions of the shank portion but also preventing warping, a common fault of other wooden propeller blades.

The successful development of an adjustable pitch propeller is a logical stepping stone to the development of a controllable-pitch propeller of the same relative size. The Freedman-Burnham Engineering Corporation, therefore, did a considerable amount of research, design, and testing in connection with controllable-pitch propellers ranging from 90 to 250 hp. to be produced at a price comparable to the requirements of the light plane field.

* Vice-President and Chief Engineer.

On Every Battlefront—

You'll find **N-A-X** *9100 Series of Alloy Steels*

There is hardly a theater of war today where N-A-X 9100 Series is not at the beck and call of our armed forces. If you looked for it, you wouldn't find it. It's there, though, in tanks, bombs, trucks, anti-aircraft and other types of guns and armament. And there it will stay until Victory is won.

N-A-X 9100 Series is an outstanding achievement of Great Lakes engineers and metallurgists. (*It is basically an alloy steel, with all strategic elements carefully balanced and held to an absolute minimum.*) It is being supplied in two general grades, with and without molybdenum, all other components of the analysis being held constant.

GREAT LAKES STEEL CORPORATION
Detroit, Michigan
Sales Offices in Principal Cities

NATIONAL STEEL

Division of
NATIONAL STEEL CORPORATION
Executive Offices · Pittsburgh, Pa.

General Electric Activities for the Aviation Industry

D. R. SHOULTS*

THE PHENOMENAL GROWTH of the aviation industry in the past ten years has provided the essential opportunity for the General Electric Company to be of service to the industry. In reviewing our Company's activities in this period, we find that the equipment we have built and to which we attach the greatest importance has been used in connection with the frontiers of the progress of the aviation industry—that is, in terms of higher altitude, higher speed, long range, and higher fire power for military aircraft.

Supercharger Developments

The story of Dr. Sanford A. Moss and his development of the turbosupercharger to a practical degree has often been told. Dr. Moss's lifelong work in the field of gas turbines and centrifugal compressors culminated in the production of a most effective aid to military aviation and, we expect in the future, for civil aviation.

Electrical Equipment

The General Electric Company has contributed to the full measure of its engineering experience and background as designers of electrical equipment in the development and production of high-capacity electrical generators, regulators, and distribution and wiring systems in the present-day aircraft. Development in this connection proceeds rapidly, and it is difficult to see the limit in the importance of the electrical equipment as aircraft become larger and more complex in function.

The General Electric Company was a pioneer in the aircraft gun turret field. It has been instrumental in the development and production of electrical equipment for many of the turrets in combat use at present.

High-Altitude Ignition

Recent developments in high-altitude flying have indicated that apparatus previously considered adequate and successful suffers in operation at extreme altitudes where today's planes must fly. Typical of this type of apparatus is the ignition system for the aircraft engine. Because of its intimate connection with the turbosupercharger development with a consequent recognition of the need for high-altitude equipment, an extensive development program has been carried on to provide suitable high-altitude ignition systems. Out of this program have come several new principles.

Instruments

Instruments are the nerve center of an airplane. In all three types of instruments, that is, engine instruments, flight instruments, and navigational instruments, the Company has been active in design and production.

Control Devices

Electrical control devices such as relays, contactors, switches, and solenoids are a natural product for the Company. A number of these now being produced are of conventional design; others are of exceptional performance. In the latter class are various highly sensitive relays and temperature control systems, including a miniature switch believed to be the smallest self-contained switch ever developed—it weighs only 0.02 lb. Other electrical control devices include solenoids to produce mechanical motion at remote points; pressure switches for control of hydraulic functions, indications of altitude, etc.; also remote positioning controls for remote operation of flaps and trim tabs.

Small General Electric fractional-horsepower motor for aircraft—it is 1 3/8 in. in diameter, weighs but a few ounces, and rests snugly in the palm of the hand.

For automatic operations, a special line of small fractional-horsepower motors in a wide range of sizes has been developed. The line ranges from such small motors to motors used to drive pumps, bomb hoists, and similar equipment.

Radio Development

Radio has become such an essential to modern aircraft warfare that it has undergone unbelievable development in recent years. General Electric has been one of the leaders in the radio development field and has been building military aviation radio transmitters and receivers for the past several years. Today all U.S. types of bombers, both those operated by our own forces and those lend-leased to our allies, carry G-E radio transmitting equipment. Some of the Navy's bombers carry both transmitters and receivers.

Plastics

Of prime importance in the manufacture of today's airplanes are the various plastic materials. Today, the Company makes more than 400 plastic parts for warplanes.

Lighting Equipment

Lighting equipment has naturally been given serious consideration, and today over 100 different lamps are available for the average bomber. These range in size from a lamp no bigger than a pea used for signal purposes to a lamp of 600,000 cp. for landing purposes.

Conclusion

This brief summary does not tell the complete story of General Electric's present responsibilities in the aviation production picture. Not only does the company build equipment for use on aircraft but also has developed special equipment for testing planes and engines and apparatus for building planes and engines. Special power recovery systems used for aircraft-engine testing have succeeded in converting a high percentage of the test power in large engine plants to useful electrical energy to help operate the factory. A number of large electrical drives for wind tunnels have been pioneered and are now contributing daily in the search for more information in connection with the design of aircraft equipment.

*Engineer, Aviation Division.

South Wind Heating MEETS YOUR NEEDS

Both combustion and exhaust-gas systems—developed and proved under flight conditions—permit unbiased study of your problems

WIDELY varying installations demand widely varying equipment. And unbiased recommendations for your needs can best be made by someone who knows and supplies *all* types of equipment.

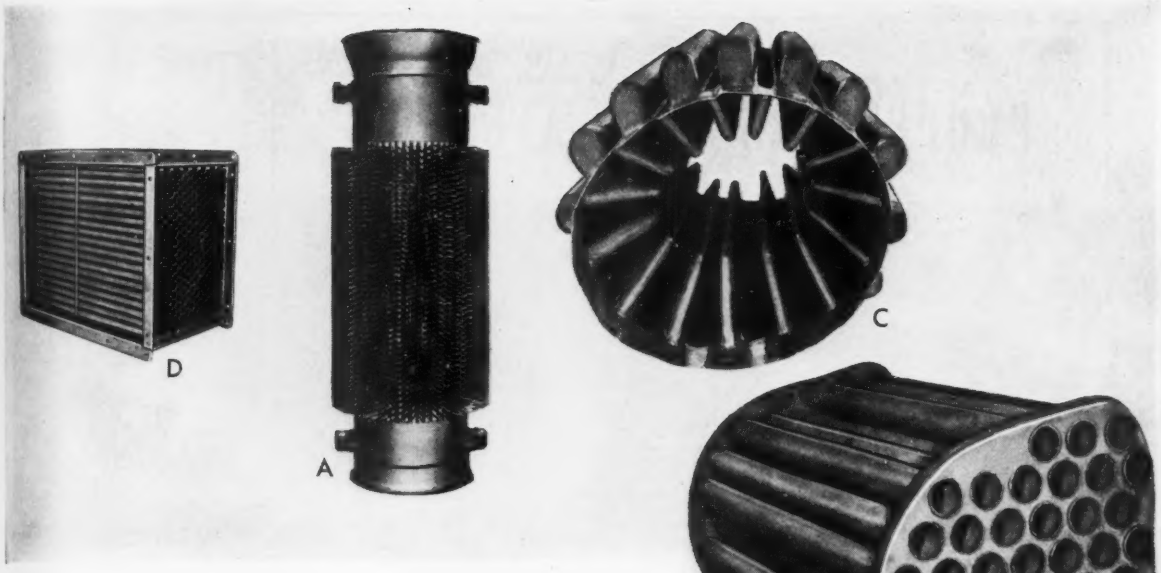
Stewart-Warner can recommend without prejudice. Because Stewart-Warner has a full line—not just a favorite to push. South Wind hermetic combustion heating, in many specially engineered forms, is serving on every battle-front—the most widely accepted aircraft heating equipment in the world.

In addition, Stewart-Warner has developed four different types of exhaust-gas heat exchangers. These new heat exchangers are the result of *two* special kinds of skill: *First,* Stewart-Warner *knows* combustion-gas heating from years of experience in making the heat exchangers which are a part of every South Wind combustion heater. *Second,* Stewart-Warner knows aircraft requirements and practices, from years of close cooperation with aircraft engineers.

Current development and design is based not only on advanced theory but on practical world-wide experience. Engineering facilities unheard-of in ordinary heating practices are employed constantly. . . . Facilities for producing exhaust gases ranging up to 3 million Btu/hr. per unit. . . . For simulating flight conditions above the ceiling of any known plane. . . . For delivering heating equipment to you with performance known in advance. . . . And, fully developed data on each type is available on request.

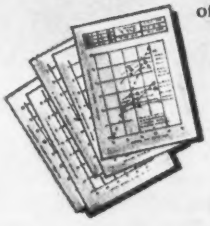
Thus, with by far the most extensive experience and most comprehensive line of combustion-gas airplane heating equipment in the field, Stewart-Warner can recommend impartially the heat sources best suited to your needs. And can engineer them in advance to the operating and installation conditions to be encountered.

For an individual appraisal of your problems, write in detail.



Equipment YOUR WAY

Shown without shrouds are four basic types of exhaust-gas heat exchangers on which complete performance data is now available. The Extended-Surface (a), Tube-Bundle (b), and Hollow-Fin (c) types are planned for passage of all exhaust gas and extraction of only the required amount of heat. The Diversion-type (d) diverts only a fraction of the gas and extracts substantially all the heat. Each type has its place in the solution of heating problems.



Now available on each of above exchangers is full data and curves showing "Heat output vs. exhaust gas rate"; "Heat output vs. ventilating air rate"; "Pressure drop vs. exhaust gas rate"; "Pressure drop vs. ventilating air rate"; "Metal temperatures at all critical points under all conditions of operation."

Continued developments in South Wind hermetic combustion heating equipment are constantly meeting new demands for compact sources capable of delivering tremendous heat where, when and as needed. In a wide range of output capacities, and with accessory equipment to fit various special requirements, they meet problems unsolved by any other means.

South Wind HERMETIC COMBUSTION *Heaters*

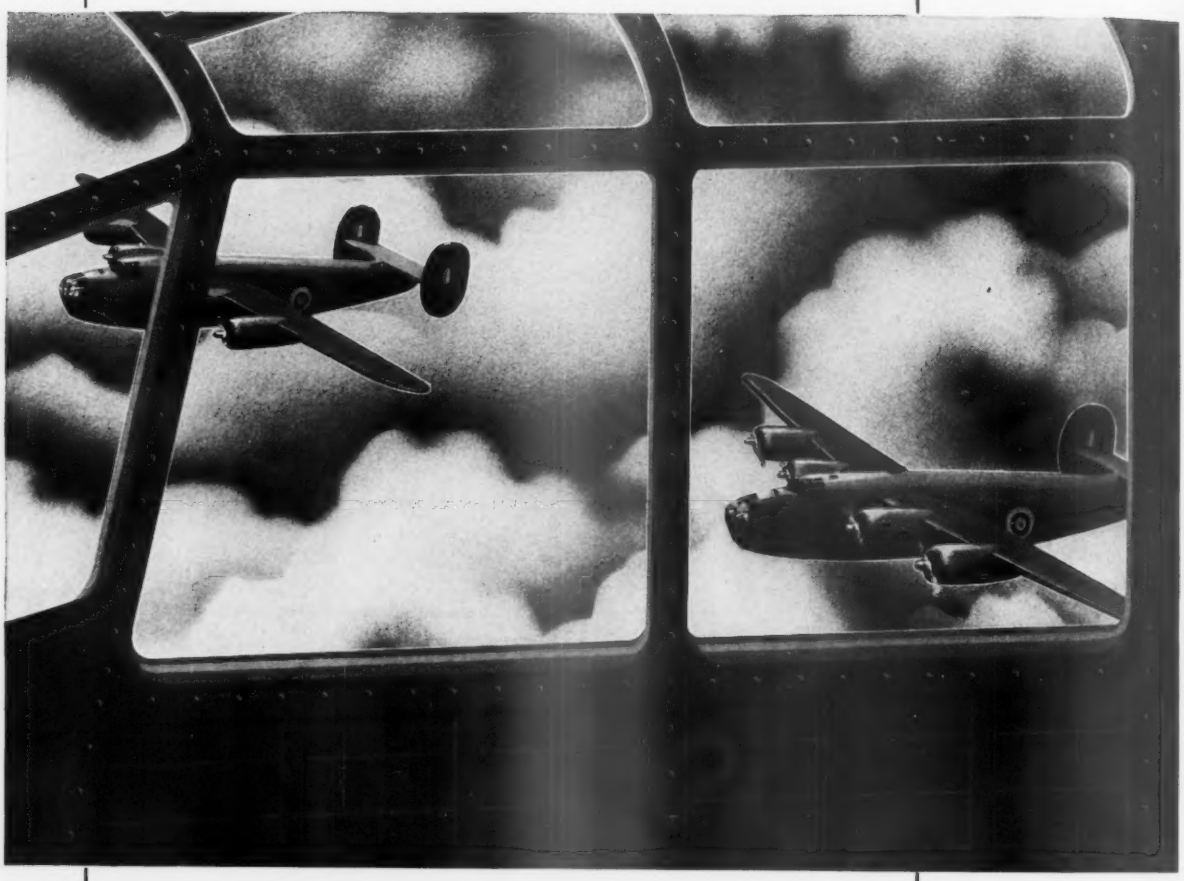
REG. U. S. PAT. OFF.

HEATER DIVISION, STEWART-WARNER CORP., CHICAGO

West Coast Office: Stewart-Warner Aircraft Heater Engineering and Service, 1273 Westwood Blvd., West Los Angeles, California

Another Product of STEWART WARNER

PROPELLERS *over the* ATLANTIC



Streaming through the skies above the Atlantic, the U. S. Army's Air Transport Command is piling up a brilliant record in delivering hundreds of Boeing, Consolidated, and Lockheed bombers to Britain.

In millions of miles of trans-ocean operations no pilot has ever had to worry about his propellers. All of these bombers have been equipped with dependable Hamilton Standard Hydromatic propellers.

HAMILTON STANDARD PROPELLERS

One of the three divisions of

UNITED AIRCRAFT CORPORATION, EAST HARTFORD, CONN.

HAMILTON STANDARD PROPELLERS

The B. F. Goodrich Company

RUSSELL S. COLLEY*

NOWHERE ALONG the aviation front has global war created greater research and development problems than in the important rubber accessories field.

At B. F. Goodrich, for example, despite 30 years' background as a supplier to aviation, engineers have had to revamp many of their ideas and techniques for adapting rubber and rubber-like materials to aeronautical use.

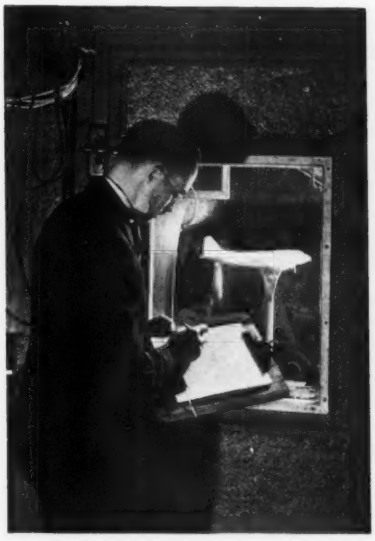
Rubber articles must function efficiently in a temperature range of more than 200°—from the −70°F. cold and lower encountered at high altitudes to heat above 130°F. in desert war.

War has lessened aviation's dependence on weather conditions, but it has not eliminated the hazard of ice or the necessity of protecting aircraft against it. Even the medium American bomber ranges from tropical to ice-forming conditions in a few hours—the same extremes may be experienced in a few minutes in high-altitude operations, even around the equator. Often such conditions are unpredictable. Deicers are indispensable safeguards. They have proved this in the aircraft-ferrying operations over the North Atlantic, where ice-forming conditions are present at all seasons, in Britain's reconnaissance patrols across the North Sea, and in the mass bombing flights over Germany.

To meet the new conditions of war, deicer engineers have had to adapt their designs to the ever increasing speeds of highly maneuverable, combat ships. Developments in deicer design, construction, coverage and operation since the pulsating rubber "overshoes" were first introduced commercially ten years ago, are proving valuable in adapting them to military needs. More and more uses are being found in aircraft manufacture for the Rivnut, the ingenious rivet permitting attachment from one surface only which B. F. Goodrich developed for fastening deicers to wing surfaces.

Ice attacks aircraft in many places in addition to the leading edges of wings and so other vulnerable surfaces such as leading edges of rudders, stabilizers, radio and pitot masts, and fixed wing slots are protected.

Propellers are safeguarded from ice accretion by a rubber "feed shoe," extending over the entering edges of the blades, along which an antifreeze solution is exuded to reduce adhesion and permit ice particles to be dislodged by centrifugal force. In addition, engine carburetors and air scoops are protected against icing as a result of researches in the company's refrigerated wind tunnel.



The author is shown observing a test in the company's refrigerated wind tunnel.

To eliminate the generation of static electricity on deicer surfaces, which, if allowed to build up a potential, would puncture the deicer and interfere with radio reception, the surfaces are now covered with a special electrical conducting compound that gradually bleeds off this static charge.

The war also is creating problems in the field of tires and tubes, which B. F. Goodrich entered more than 30 years ago with the first low-pressure airplane tire. Instead of smooth, hard-surfaced runways, combat airplanes often are required to land and take-off on all types of terrain with loads above their rated capacities and at greatly accelerated speeds. Despite these unusual conditions, reports from the fronts indicate that tires and tubes, along with B. F. Goodrich Expander-Tube brakes, are delivering excellent service.

One of the most important developments of the war is the bullet-sealing fuel cell which lessens the hazard of fire and provides greater assurance that aircraft will return from combat to their bases.

At the start of the war, 30-caliber machine guns were used preponderantly by combat aircraft. At present, the swing is toward the 50-caliber weapon and higher. Thanks, however, to the cooperation and vision of the Army Air Corps and the Navy Bureau of Aeronautics, this change in armament was foreseen and fuel cell development has kept pace and the units can withstand the higher caliber guns without leaking. Tests made on fuel cells removed from captured or downed German ships show that the American cell resists leaking more effectively from 50-caliber bullet punctures than the Axis unit does from 30-caliber bullet punctures.

Instead of vulnerable metal fuel lines, which could be knocked out of action with one shot, American combat planes now are equipped with bullet-sealing fuel hose, employing the same basic principle as the fuel cells.

Modern air warfare is fought at high altitudes. The development of high-altitude oxygen masks is one of the most interesting research accounts of the war to date. In addition to the problem of finding a standardized mask to fit the dissimilar features of Americans, the development of a satisfactory high-altitude oxygen mask posed other questions. B. F. Goodrich turned to its anode process of rubber deposition and perfected a mask that remains soft and supple at the lowest temperatures.

The B. F. Goodrich aeronautical product line includes numerous other essential rubber items—approaching 100 in all—for use on combat aircraft. Among these other items are abrasion shoes; Air Cell rubber products such as parachute seats, crash pads and like articles; shock absorber cord; matting channel rubber and sealing strips; hose of all types and kinds; cements; and grommets and gaskets almost without end.

Further utilization of the oil, ozone, and sun-resisting qualities of synthetic rubber is under way in the adaptation of this material to aeronautical use. In addition, the company's synthetic elastic material, Koroseal, is being used extensively as insulation for electrical wiring and cable, sun-resisting engine and wing covers, and other aircraft applications.

* Aeronautical Engineer.

WING TIPS

of Molded Weldwood...

Strength, lightness, durability and a non-rippling surface are achieved in these wing tips of Molded Weldwood fabricated by United States Plywood Corp.

Solve a major production problem

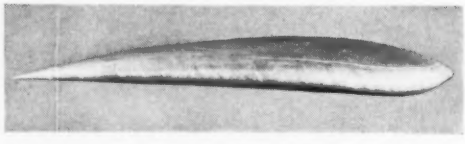
Aeronautical engineers now think in terms of plywood planes and gliders because, in Molded* Weldwood, can be developed the compound curvatures essential to aircraft performance.

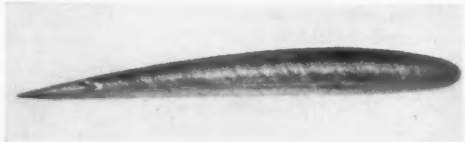
U. S. Plywood is in quantity production on these intricate molded structural units. *Pre-fabricated* Molded Weldwood parts simplify and speed fabrication.

Weldwood wing tips represent one of many types of U. S. Plywood service available to industry. Two plants are now producing fuselages, ailerons, control surfaces, ducts and tabs. Another plant is devoted to the production of floor-boards, navigator tables and special constructions combining plywood and light metals. Three large mills manufacture flat Aircraft Weldwood for ripple-free skins and rigid interior structures.

All these production facilities and also the services of a qualified technical staff of engineers, chemists, wood technologists are yours to command. Write today for illustrated booklet and complete information.

*Made by the Vidal Process U. S. Pat. No. 2073290.





NEW PLASTIC GLUE— Weldwood Plastic Resin Waterproof Glue . . . makes strong, permanent joints. Readily mixed with cold water. Available in convenient sizes, 1⅛ oz. cans up to 100 lb. drums. Literature, FREE sample on request.

WELDWOOD
REG. TRADE MARK

WELDWOOD is the family name of plywood products made by United States Plywood Corporation.

UNITED STATES PLYWOOD CORPORATION, New York, N. Y.

World's Largest Producer of Plywood

W. & L. E. Gurley

H. M. DIBERT*

In writing a history of the technical contributions made by W. & L. E. Gurley to the aviation industry during the past ten years, a record of previous accomplishments will serve to give a better perspective.

Founded in 1845 by two brothers, William and Lewis E. Gurley, the firm has been and still continues to be a family concern. The founders were graduate engineers who entered their profession at the time of the westward expansion of this country. They soon saw the need for better surveying instruments, more adpatable to the expanding frontier.

Two fundamental policies were established: one, that of studying the requirements of the times; the other, that of finding the best way to do the job.

Surveying Instrument Development

This inquiring and progressive attitude resulted in many improvements to surveying instruments. Gurley made the first surveying transit of aluminum in 1876, a practice at that time uneconomical but revived during the past 20 years to such an extent that practically all present-day production of that instrument is of that material.

The drawing of platinum into fine wires for instrument cross-wires and many experimental uses was an exclusive development of Gurley in 1876 and remained so for many years thereafter.

Improvement in automatic dividing engines were made in 1885. The design was characteristic of the Gurley independence of thought, and the present-day superiority of this design in the matter of durability, accuracy, and speed of production testifies to the foresight of the Gurley engineering and research staff.

Nonferrous Alloy Research

In a search for the best materials out of which to make surveying instruments, Gurley had conducted an exhaustive study into the properties of nonferrous alloys, the results of which are now a part of the records of the U.S. Bureau of Mines.

It is this continuous development over a period now nearing the century mark which has made possible the modern surveying instruments, unexcelled in quality by any previously made and turned out at a speed hitherto thought impossible.

How does this contribute to the aviation industry? The increase in the size of airplanes has made necessary the use of surveying instruments in their rapid and accurate assembly. Gurley instruments have played their part in this assembly of airplanes and in the construction of landing fields, hangars, buildings, etc.

Coincident with the development of surveying instruments, Gurley has lent its facilities to the development and manufacture of other products: Thermometers, Physical and Electrical Laboratory Apparatus, Hydraulic Engineering Instruments, Standard Precision Weights and Measures, and Testing Instruments for testing paper and fabrics.

Navigation Instruments

In 1934 Mr. Harold Gatty brought his idea of a drift indicator to Gurley. This instrument can be varied in design to suit most any type of airplane. It has found its greatest use in overseas ships (landplanes generally travel on a radio beam). Sealed models have been produced for stratosphere planes and retractable models for seaplanes, where the water will obscure the lenses. They can be used by pilots, navigators, or bombardiers.

The simplicity and cheapness of uncorrected lenses has been generally satisfactory, but in cases where other than unit magnification or a larger field of view were desirable corrected lenses were used. The standardization of many of the parts has made it possible to modify the design so as to adapt itself to any type of ship and also to furnish replacement parts for field overhaul and servicing.

This same year a bearing circle was developed for Dr. Richard U. Light. This was found valuable on his round-the-world trip, but its subsequent use has not been extensive. It consisted of a plate with quadrant divisions that were permanently aligned with the axis of the plane. It was hung in gimbals for quick leveling or manipulation to any plane. A circle, graduated to 5°, could be rotated within the outer circle and could be set to the course bearing. A movable open sight Alidade could be rotated above the divided circle for reading the azimuth angle to distant objects. It was used for plotting the plane's position by the intersection method.

In 1937 a quantity of the Air Corps Type A-2 Pelorus were made and special tools and equipment were developed for their convenient and accurate assembly and adjustment.

In 1938 Gurley worked with Pan American Airways in developing their design of Pelorus, which possessed several unique features.

Meteorologic Developments

One way of obtaining data on the strength and direction of the wind at upper levels is to release a pilot balloon and measure its azimuth and elevation at timed intervals until the balloon is lost to sight. Two factors contributed toward losing the balloon. Focusing was so minute at extreme distances that a sensitive touch was necessary not to over or under focus. Gurley improved the light-gathering power of the objective lens and permanently focused it at infinity, so that the sharpness of image improved with distance and the observer was relieved of the eyestrain of focusing. Telescopes of the magnification used of necessity have restricted fields of view. In a jumpy atmosphere it was not uncommon for the balloon to move faster than the manipulating speed of the observing instrument. Gurley introduced a tangent wheel device that made it possible to follow the most rapid balloon changes. In fact, the speed of manipulation was so great that the Gurley Pilot Balloon Theodolite was actually used to follow the turn at the pylons of the racing planes at one of the National air meets. During the summer of 1937 Gurley engineers, working in collaboration with Pan American Airways, made shipboard trips to Europe studying this type of Pilot Balloon Theodolite, the development of which is still under way.

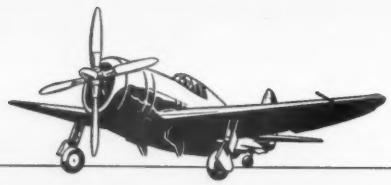
Knowledge of the surface strength and direction of the wind is important to pilots landing at airports, particularly with the increased size and loads of airplanes. Gurley has developed the Electronic Anemometer that gives velocity readings instantaneously. This instrument has demonstrated that the velocity of the wind varies continually and that the maximum and minimum readings are quite different from the readings obtained with other types of anemometers, which by reason of the time required gave an average value.

Research is going on continuously, and many new ideas that will contribute to the effectiveness of airplane navigation are now under consideration and study. Gurley continues to follow the policy of trying to meet the needs of the times.

* Secretary and Treasurer.

V

OLUME
FOR VICTORY



HERE IS A GLIMPSE . . .

No single photograph could show you *all* of the Republic P-47 Thunderbolts that are on the line at Farmingdale and at other points . . . Their thunder in the uppermost regions of strato-combat will contribute mightily to the crescendo of victory.

REPUBLIC AVIATION

REPUBLIC AVIATION CORPORATION

REPUBLIC AVIATION

FARMINGDALE, L. I., NEW YORK

Nickel Contributes to the Progress of the Aviation Industry

T. H. WICKENDEN*

DURING THE PAST TEN YEARS when the aviation industry was striding forward to its present peak position, many industries were closely affiliated with it. Among these was the nickel industry, which has maintained a constant association and has contributed many materials of construction that have been helpful in aeronautical progress.

All branches of the metal industry have shared in the development of materials containing nickel, not specifically the nickel industry. Many of the basic materials have been available for some time, but the demand for high quality and performance has been a challenge to the metal industry and has resulted in marked improvements in the mechanical properties available, together with methods of processing and fabrication.

The largest use of nickel from a tonnage standpoint enters into constructional steels, which are widely used because of their combination of high strength, toughness, resistance to impact (especially at low temperatures), fatigue properties, and for certain applications compositions can be selected having excellent welding properties. Crankshafts, connecting rods, wrist pins, reduction gears and steel propellers—these are some of the uses to which these materials are often put. The use of these steels is by no means confined to the power mechanism alone, for they may be found in substantial quantities throughout the fuselage, engine mounts, important forgings, bolts, landing gear, shock absorber, and many other parts. On military planes the thin, tough armor plate has its component of nickel. Many steels are known to lose their impact properties and become brittle at Arctic temperatures, while nickel steels are available which will retain ample toughness at the lowest temperatures encountered in aircraft operation.

Nickel is an important constituent in the heat and corrosion resistant alloys, ranging from 6 to 8 per cent of nickel in ordinary stainless steel; 14 to 15 per cent of nickel in exhaust valve alloys; turbosuperchargers built of high strength, heat-resistant alloys contain substantial quantities of nickel as do electrical resistance alloys and Inconel, while spark-plug wires contain 96 to 98 per cent. Stainless steel and Inconel have been widely used for fire walls, collector rings, exhaust manifolds and cabin heaters.

Stainless steel finds many applications in modern aircraft as a constructional material and, with the increase in size of planes, will undoubtedly become more widely used. Its selection is based upon an unusual combination of properties besides its primary function of resistance to corrosion and oxidation. In certain compositions it can be cold-worked to high mechanical properties, combined with flat, unwarped surfaces especially in thin sheet and strip. To secure these properties in a lower alloyed material would require a quench and draw treatment with its accompanying danger of scaled surfaces and warped sections. The "shot welding" process permits welding of this material without serious loss of strength and corrosion resistance and has been the "key" to the utilization of stainless steel as an economical constructional material. Its characteristics and fabrication properties are so different from the aluminum alloys that a direct substitution of one material for the other is not possible, and a successful application of stainless steel as a constructional component must be engineered with this in mind. While stainless steel has been used extensively in the construction of small aircraft, apparently certain limitations have been found in the thickness of section which can be produced commercially so that it has often been necessary to use heavier sections than the design required. With larger aircraft, the limiting commercial gauges can be utilized to full advantages and a better balanced stress-weight ratio secured.

T. H. Wickenden.

Many special purpose alloys contain a high percentage of nickel such as Alnico used in magnetos (its high magnetic properties permit a saving in weight); Inconel and stainless steel, being nonmagnetic, are used on the instrument board and near the compass and Monel for special parts calling for high resistance to corrosion. Other parts are made of "K" Monel, "KR" Monel and "Z" Nickel. Materials with low expansion properties such as Invar often finds service in combination with high-expansion materials in thermostatic alloys. Nickel also plays an essential part in thermocouples for indicating engine temperatures.

Small fighters and large bombers alike make use of nickel cast iron. Training planes, for instance, use this material for cylinders. Ni-Resist, the high expansion and heat-resisting cast iron, has been found to match up well with aluminum alloys for use as cylinder liners, valve seats and valve guides. Brake drums of heavy transport planes utilize certain combinations of nickel, molybdenum and chromium with improved results in resistance to wear and heat-checking.

Aluminum alloys count strongly on the presence of nickel, especially those required to retain their strength at elevated temperatures—pistons and cylinder heads. A nickel component is found in aluminum bronze for valve seats since it maintains the hardness at operating temperatures.

With the field of radio and communications such a vital part of the successful operation of aircraft, mention should be made of the large amount of nickel entering the construction of the numerous tubes required.

Thus, in a multitude of ways, nickel alone and nickel alloyed with a variety of strategic metals is doing its share in keeping American aviation at peak performance. Whether in war or in peace, the nickel industry is contributing much to the continued success of this nation's aircraft wherever they are flown

* Assistant Manager, Development and Research Division, The International Nickel Company, Inc.

Walter Kidde & Company, Inc.

ARTHUR M. DOXSEY*

WALTER KIDDE & COMPANY, INC., made its first contribution to the aviation field in 1926, when, in cooperation with the Navy Department, it perfected a carbon dioxide system for airplane-engine fire protection. This system was an adaptation of the high-pressure carbon-dioxide equipment previously developed for marine and industrial hazards.

By 1932 several more items of aviation equipment had come out of the Kidde laboratories in Bloomfield, N.J. These included a lightweight alloy cylinder for airplane use, airplane waterwings to keep landplanes from sinking when forced to land on water, and carbon dioxide crash trucks for guarding flying fields and bases.

In 1932 the first of the now famous carbon-dioxide inflated life rafts was introduced. This consisted of a collapsible rubberized cloth raft and a steel bottle of compressed carbon dioxide similar to those used in fire-extinguishing systems. The gas was under a pressure of 850 lbs. per sq.in. at 70°F. and, when released, expanded to 450 times its stored volume. Thus, a flask the size of an ordinary milk bottle contained sufficient gas to supply buoyancy for a three-man raft. The same year Kidde engineers perfected an inflatable life vest for use by fliers forced to bail out over water. This worked on the same principle as the raft.

The next new development, introduced in 1933, was an automatic detector for the airplane-engine extinguishing system which gave the pilot immediate warning once fire broke out in the engine.

In 1934 Kidde work in compressed gases resulted in the development of cylinders and valves for oxygen breathing apparatus for high altitudes, which greatly increased fliers' operating ceiling.

Three years later further experimental work in the Bloomfield laboratories resulted in the perfection of a system for rapidly expelling gasoline from wing tanks with carbon dioxide, thus making for greater safety in landing and reducing the hazard of fire in the air.

With the outbreak of war in 1939 Kidde research in the aviation field expanded enormously. New developments piled on top of each other with such rapidity that it would be impossible to detail them chronologically. They are therefore presented by fields—fire protection, fire detection, inflation equipment, and power actuation.

John Kidde, Vice-President of Walter Kidde & Company, Inc., demonstrates how a shatterproof cylinder can be pierced by a 50-caliber bullet without breaking into pieces.

FIRE PROTECTION

First innovations in the fire-extinguishing category were new methods of distributing the carbon-dioxide discharge to insure the complete smothering of flames in both radial and in-line engines in the face of the terrific air blasts experienced in modern pursuit craft and bombers. A special shatterproof cylinder was perfected to meet the hazard of enemy gunfire. Where the old type of cylinder might break into fragments more dangerous than the bullets themselves if hit, the new cylinder will not burst. Today, the shatterproof cylinder is being used on all types of combat carbon-dioxide and oxygen equipment.

A third development in the fire-extinguishing category has been the vapor dilution system for auxiliary gas tanks. A refinement of the earlier gasoline expulsion apparatus, it enables the pilot to purge and dilute the explosive vapor in empty and near empty auxiliary tanks upon entering combat, thus negating the explosion hazard from incendiary and tracer bullets. A still more recent adaptation of the same principle is now being used to explosion-proof wing and fuselage spaces around gas tanks. Today, a Kidde-designed apparatus feeds inert carbon-dioxide vapor into these spaces to eliminate this hazard.

FIRE DETECTION

The outstanding Kidde development in the detection category has been the impact actuator. This is a small pendulum-operated device. An impact greater than a predetermined force, such as that of a crash, swings the pendulum free, making an electrical contact which in turn sets off the plane's extinguishing system.

INFLATION EQUIPMENT

In inflation equipment, three developments stand out. The first is the flotation bag perfected for the R.A.F. Ferry Command. This is a large rubberized bag with an attached cylinder of compressed carbon dioxide, which is stowed in the cabin of landplanes to be flown across. In case of a forced landing at sea, the bag is inflated with carbon dioxide and keeps the plane afloat long enough for the crew to escape.

The second major development is the automatic pop-out raft. This is carried in a special compartment in the top of the fuselage. When a plane crashes into the water, water sensitive detectors on the under side of the wings open the hatches and inflate the raft in a matter of seconds.

The third inflation device, just introduced, is the one-man parachute raft, which is worn by the flier as a seat pack. When he is forced to bail out, the raft stays right with him and, by turning the valve on a cylinder containing ¾ lb. of carbon dioxide, it can be transformed into a 5-ft. rubber boat complete with eleven items of equipment in the matter of a few seconds.

POWER ACTUATION

The fourth field of new carbon-dioxide developments is power actuation, an entirely new use for the gas, evolved by Kidde engineers to take advantage of the latent force—30,000 ft.lbs. per lb.—of the compressed gas. Power actuation cylinders are used as an emergency source of power to open bomb bay doors, lower landing gear, and apply brakes. In case the regular hydraulic system is shot away or otherwise damaged, a valve is opened releasing the gas into the lines. A separate cylinder is employed for each operation and is recharged after use.

* Chief Engineer.

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BERRYLOID

AIRCRAFT FINISHES

Ten Years of Kollsman Development

J. CLIFTON CARR*

A TEN-YEAR REVIEW of the engineering history of the Kollsman Instrument Division of Square D Company is in reality a review of the outstanding developments and trends of precision instruments during their period of greatest growth. This is in turn linked to the development of blind flight which brought new demands on the accuracy and dependability of these instruments because the pilot for the first time began to rely solely on these aids for the safe piloting of his plane.

By 1932 the Kollsman Instrument Company had grown from a "one-man laboratory" of 1928 to an organization employing some 30 or 40 persons. The major portion of its activities was the production of Sensitive Altimeters, an original Kollsman design. About this time further improvement was made on the Sensitive Altimeter to include compensation for temperature effects on the instrument at any altitude by the use of a bimetallic compensator on the aneroid unit.

Turning to other instruments, temperature and altitude compensation was provided for climb indicators by an arrangement in the capillary restriction. The addition of a float to the magnetic unit of compasses resulted in improved performance for these instruments with less wear on the pivots.

Demands for greater accuracy were also being felt in the engine instruments and the self-sustaining aneroid unit was applied to the Manifold Pressure Gage, producing a more accurate instrument. Later, a further development of this was made with the Vacuum Cartridge Manifold Pressure Gage, which excluded gases entirely from the mechanism and extended the instrument life considerably.

The Tachometer also received some attention, first with the application of the magnetic tachometer to aircraft use with the necessary compensation for temperature and pressure variations and later with the development by Kollsman of the electric (remote indicating) tachometer. The accuracy to within 10 r.p.m. and steady indication of these instruments permitted more correct adjustment of the engines.

By 1938 the number of Kollsman employees had increased considerably and more than 50 per cent of the Army, Navy and commercial instrument business (exclusive of gyroscopic instruments) was being placed with the company. This growth had necessitated several moves to larger quarters, the latest step being the occupation of a building of some 70,000 sq. ft.

A direct reading magnetic compass with a vertical dial and pointer was another important new Kollsman development. A new alloy of high magnetic strength made possible this new instrument. Besides the indicating features of this Direction Indicator, as it was called, it had the quick response of the pilot's compass and the steady indication of a navigator's compass—an important advance in compass design had been made.

*Kollsman Instrument Division, Square D Company.

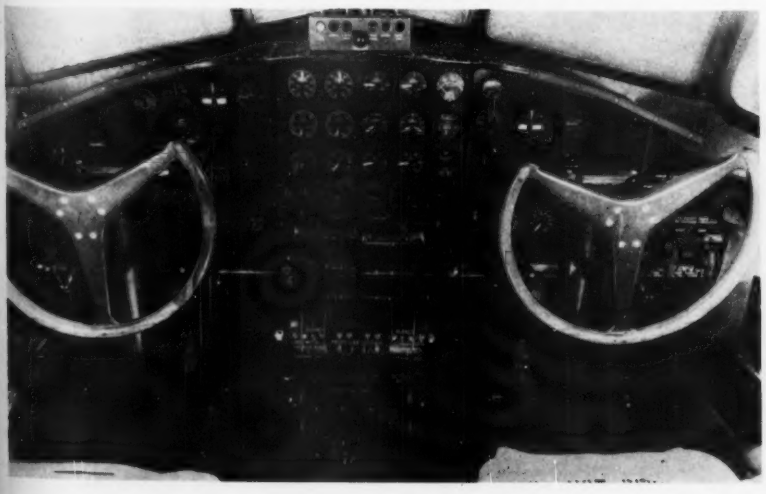
Dual Tachometer and Synchroscope—A three-in-one combination developed by Kollsman in 1942.

With the increase in the size of planes, long connecting shafts to the instruments became necessary and some method of remote indication was needed. Using the principle of the small self-synchronous motor, Kollsman designed the Telegon system of remote indication. Originally used primarily for engine instruments and Link Trainers, the addition of armor plating for the pilot made necessary a remote indicating compass, and the Telegon system was adapted to this instrument. Interchangeable units and the use of several indicators without loss of accuracy are two important features of this design.

In 1940 the Square D Company of Detroit purchased the Kollsman Instrument Company and it became the Kollsman Instrument Division of Square D Company.

In addition to a tremendous increase in personnel and manufacturing space characteristic of the industry in the present emergency, Kollsman has also expanded its activities into the optical field; first, in the manufacture of prisms and other precision optics and, more recently, in the design and manufacture of complete Drift Sights and Binoculars.

A complete new research laboratory has also been established and the regular experimental and research laboratories considerably expanded. Considerable attention has been directed at redesigning the instruments for mass production with a resulting increase in production but new designs are in process as well. One of the most recent developments was a Combination Dual Tachometer and Synchroscope giving the pilot three instruments in one with the resulting simplification of the instrument panel.



Official Photograph, U.S. Army Air Forces

1942—A modern four-engined bomber instrument panel with 44 separate instruments visible.

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Lear Avia, Inc.

L. GELIN*

In the initial stage of its activities, Lear Avia, Inc., formerly Lear Developments, Inc., was particularly prominent in the field of radio equipment for itinerant fliers. Though Lear Avia, Inc., originally was purely a radio engineering and manufacturing firm, many of the accessories originally conceived for radio applications found such favor in other aircraft applications that in 1940 the firm expanded its activities in the aircraft accessory field and now devotes only a small percentage of its development and production facilities to radio work.

Outstanding in the electrical and mechanical equipment field for aircraft is the contribution of the Lear "Fastop" electromagnetic clutch and the Lear lightweight high-output electric motors. These drive various Lear mechanisms for operating various parts of airplanes such as engine cowl flaps, Prestone radiator shutters, etc. The development of these devices not only involved the electrical power unit itself but also the driven actuating devices, so that the complete assembly could be delivered to the aircraft mnaufacturer ready for installation in the airplane.

The Lear "Fastop" electromagnetic clutch makes available a means of automatically disconnecting the motor armature, with its high inertia, from the driven mechanism the instant the motor current is interrupted, at the same time applying a brake to the driven mechanism, stopping it in a few degrees of rotation. The clutch is built as an integral assembly with Lear electric motors. These motors are lighter and smaller than any others of equal power in the aircraft field. Following aircraft practice, all parts and materials not doing useful work were eliminated. The design was studied to produce motors as small as practical, resulting in units of almost solid metal work. Very lightweight motors with outputs from 2 watts to 8 hp. are possible with only five basic frame sizes.

In the development of mechanical devices driven by Lear electric power units, Lear Avia pioneered in the use of flexible shafting for power drives in aircraft. It pioneered in the use of screw jacks for the operation of engine cowl flaps, and engine temperature control shutters. Special shock absorbers have been developed to take up vibration and at the same time provide universal joint action. Today, Lear Avia is believed to be the largest manufacturer of aircraft screw jacks in the U.S.A.

Recently, Lear Avia developed a line of linear actuators around its standard motor frame size. These are each a complete power unit connected directly to the driven mechanism without any intermediate devices. Each unit consists of an assembly made up of a Lear motor, Lear Fastop clutch, reduction gear incorporating a power screw that moves the driven mechanism.

Lear Avia has also developed complete electrical-mechanical means for preset controls whereby the pilot may move a control to a desired position and a power unit remotely located will move to this position and at the same time indicate the accomplished movement on a position indicating dial in the cockpit.

A most recent Lear Avia development is a means of synchronizing electrically driven power units using only a direct-current power source. As a multiplicity of power units can all be thus tied in together, many new applications have been found such as wing flaps, control surface tabs, etc. The synchronous motors may be of different power output and the system works independently of the direction of rotation of the different motors.

In the radio field, Lear Avia, or rather Lear Developments, Inc., made its first appearance in 1932 with the first mass production Aircraft Receiver for itinerant fliers. In 1937 the unit was redesigned. Its main distinctive features were that the I.F. unit of the receiver, Modulator and Amplifier of the transmitter were built into a separate unit together with the power supply.

In 1938 the Lear developments brought out the first Rotary-type motor-driven Band Switching Mechanism which made the UT6 transmitter one of the most successful units produced on the market. A portable transmitter receiver was later developed for exploration and military purposes. The unit is contained in a single box with its own power supply and could be readily connected to a storage battery.

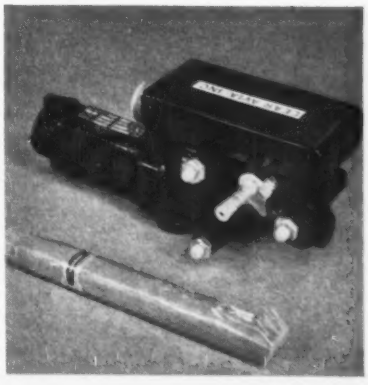
Shortly afterward Lear Avia developed for a special military application a high-power (125 watt) Master Oscillator Transmitter with a high and low frequency band 300 to 600 and 3,000 to 6,000 kc. This unit was developed for a combat plane and had to be designed with particular regard to weight and dimensions.

The latest development in the field of transmitter-receivers for the itinerant flier is the Lear PX, which consists of a single box containing transmitter-receiver and direction finder with simultaneous range filter and relay for fixed and retractable antenna.

The most notable achievements of Lear Avia are, however, in the field of direction finders which work was begun early in 1935. The first commercially available direction finders with left-right indicator and DC loop motor was the Model ARC 5. Successive developments of this unit, the Model ARC 6, led to the first Automatic Direction Finders commercially available for the itinerant flier. Subsequently, the unit has undergone further improvements in the Model ADF 7 with the introduction of a large-type azimuth indicator and a quadrantal error corrector by means of a mechanical cam located at the loop motor.

This gave birth to the Learmatic Navigator which combined a Radio Direction Finder and Directional Gyro in one, superposing the above indications so that the pilot could by direct reading instantaneously obtain information required for straight-line navigation, low approach landing, and for a solution of a number of ordinary navigation problems which are encountered in military and airline navigation.

The contribution of Lear Avia in the field of antenna reels is particularly notable in the fast, commercially available, automatic motor reel antenna. This unit introduced the practical application of the Lear Fastop motor and clutch and also the torque operated limit switch. The light weight of this unit, simplicity of operation and compactness are the most outstanding features of this equipment.



"AA" gear box (torque 165 in.lbs.).

* Assistant to the President.

HOW TO STRENGTHEN *Aluminum* THREADS *with the*

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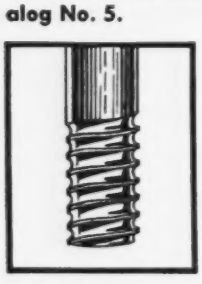
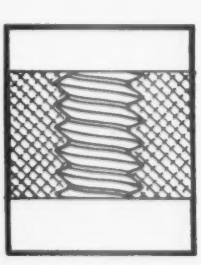
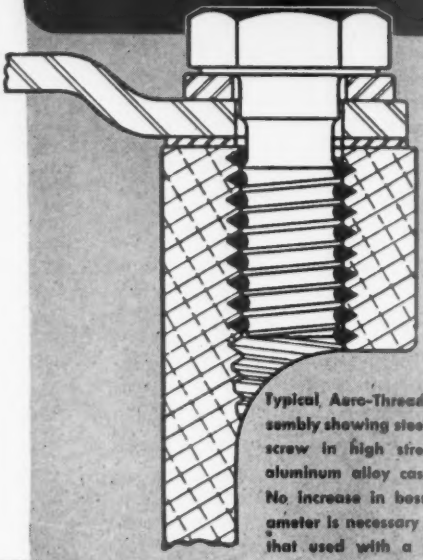


Profile of thread form used on screw or externally threaded member. This circular section minimizes the causes of failure common to standard vee threads.

The Aero-Thread Insert has a cross section that fits the modified vee tapped thread in the aluminum part and also the circular thread in the screw. It is made of phosphor bronze or stainless steel.



Profile of thread form tapped in the aluminum part. This modified American National thread reduces the likelihood of failure resulting from the sharp angles at the root of the standard thread.



Typical Aero-Thread assembly showing steel cap screw in high strength aluminum alloy casting. No increase in boss diameter is necessary over that used with a stud, since the Aero-Thread System eliminates the need for the heavy bronze bushing generally required in the conventional assembly.

AERO-THREAD ADVANTAGES

1. **Effectively protects threads in light alloys against wear and damage.**
2. **Increases impact and fatigue capacity by permitting use of higher tensile screws and studs.**
3. **Increases holding power of tapped holes in light alloys.**
4. **Provides non-seizing, non-wearing thread surface.**
5. **Compensates for difference in expansion of steel screw and light alloy member.**
6. **Eliminates need for oversize screws and studs or for re-tapping light alloy threads when replacements are necessary, thus simplifying servicing.**

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AERO-THREAD

U. S. Patent Nos. 2,150,875, 2,150,876, 2,152,681, 2,210,061, 2,244,824, 2,262,450, 2,257,089. British, Canadian and other foreign patents issued and pending.

AIRCRAFT SCREW PRODUCTS COMPANY, INC.

47-23 35th STREET • LONG ISLAND CITY, N. Y.

New Departure Division, General Motors Corporation

T. C. DELAVAL-CROW*

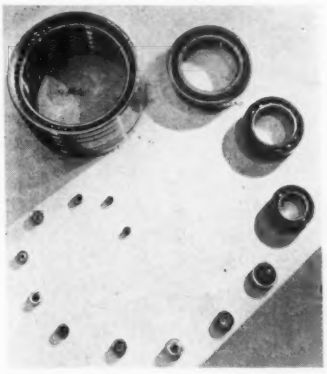
IN DESIGNING and producing ball bearings for the aircraft industry, New Departure has directed its activities along various definite lines in anticipation of the more or less certain requirements of the industry. That is, after the beginning of any form of automotive development, there has inevitably followed a relatively constant effort to advance or improve along such well-defined lines as greater power, higher speeds, greater accuracy, longer life, or combinations of such advancements.

This has been the case with the aircraft industry and particularly so within the past decade. All of these lines of improvement being more or less intimately concerned with the question of bearings, New Departure has worked to develop increased bearing capacity to meet the demands of greater engine power, has steadily improved bearing precision to permit higher speeds and greater accuracy in operation of many aircraft parts, and has been able to further extend average bearing life with consequent longer life for the aircraft parts supported. In addition, considerable advances have been made in the direction of prelubricated, self-sealed bearings for increased life and reduced maintenance.

Being restricted to a considerable extent by standardized boundary dimensions, the problem of increasing bearing load capacity has necessarily involved such matters as improvement in bearing steels, different methods of forming and heat-treatment, and various refinements in bearing internal design and proportions.

Because such work has been carried forward vigorously by New Departure for a great many years, it has been possible within the past decade to coordinate and apply in a practical way much of the knowledge thereby gained. As a result of the development, therefore, of a really superfine steel and various innovations in its treatment and fabrication into bearings, the occurrence of fatigue has been considerably delayed and useful bearing life definitely extended. While this has been of great importance to such as engine, reduction gear and propeller blade bearings, its benefits, of course, have extended largely also to the many ball bearings for other aircraft component parts.

* Chief Engineer.



Typical New Departure Bearings.

The number of hours which American-built aircraft engines will operate under full service conditions before major overhaul is required, have been vastly increased in the past few years. This is fully attested to by great numbers of flights of remarkable duration and under extremely severe operating conditions. Fine as the design and construction of these engines are, they could not consistently establish such records without antifriction bearings having exceptionally high and uniform endurance characteristics.

It is common knowledge that in the manufacture of many products in large quantities, the test performance of certain individuals often exhibits qualities far beyond the average of their kind. In the fabrication and testing of vast numbers of experimental bearings representing many different steels, different heat-treatments and different internal design variations, New Departure has increasingly searched out the reasons behind the performance of all such exceptional individuals.

From a scientific consolidation of the outstanding facts thereby proved, several results of great importance to New Departure's aircraft bearing production have been gained. First, as previously noted, the average fatigue life of bearings has been definitely increased. But of equal, if not greater, importance is the fact that the deviation of bearings from the standards set up for them has been drastically reduced or narrowed. Thus, there has been gained a great advance in uniformity which, after all, is the ultimate criterion of reliability and the real goal in the mass production of a precision article.

Another bearing problem to which New Departure has made definite answer has been that of bearing maintenance. It is generally recognized that if ball bearings of reputable manufacture are once properly enclosed and lubricated their maintenance becomes a matter of small moment. This is of especial importance in large aircraft, where small control motors and other operational devices may be located at a great many points not readily accessible, particularly during flight.

Having pioneered and developed the prelubricated, self-sealed ball bearing, New Departure has been in a position to offer many advances in bearings especially designed for practically maintenance-free operation in out-of-the-way places. Working with the foremost oil companies, there have been developed certain lubricants suitable for temperature ranges varying from considerably below zero to as high as any to which antifriction bearings are subjected. At the same time, seals for the bearings have been perfected which not only prevent loss of lubricant and entrance of dirt but which are so free-running as to have little or no frictional effect upon the rotation of the bearings.

Until a comparatively short time ago there had been little demand in this country for ball bearings of minute proportions for precision support of the various oscillating or rotating elements of many navigating or flight control instruments. However, with years of experience in manufacture to microscopic tolerances, New Departure produced special machinery and other manufacturing and gauging equipment within less than three months after orders to produce certain extremely small precision instrument bearings. Some of these bearings are scarcely more than $^1/_{10}$ in. in outside diameter, yet contain a complement of balls approximately $^4/_{100}$ in. in diameter and spaced by a separator.

The variety of problems which have been met and answered in forming, grinding, gauging and inspecting balls and bearings from this size up to the large bearings weighing many pounds each, may be readily visualized by any engineer. But as engine power is increased as it certainly will be and as precision demands grow ever greater, New Departure will continue to work to meet the demand with still better ball bearings.

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Norma-Hoffmann Bearings Corporation

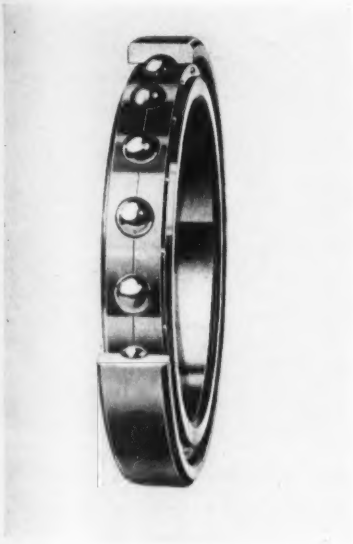
D. E. BATESOLE*

INTIMATELY ASSOCIATED with the aviation industry for the past thirty years, the Norma-Hoffmann Bearings Corporation pioneered many new types of bearings to meet the specialized needs of the aircraft designer. Since the first ball bearings for aircraft controls were made, many distinctly new types such as double-row self-aligning ball bearings with metal shields (now known as the "DS" series), single-row self-aligning ball bearings with removable felt seals (now known as the "KSF" series), push-pull tube guide bearings with both metal and felt seals and many individual types of extra small and extra light ball bearings have been introduced.

CONTROL BEARINGS

The essential characteristics of control bearings are compactness, light weight and maximum static load carrying capacity, since these bearings are normally required to function through a small angular movement only or for a few revolutions at most. Through the use of raceway curvatures conforming closely to the ball curvature and a full complement of balls without a retainer or separator, load requirements have been fully met with units of minimum size and weight. Closely fitting metal side shields or felt seals have been used to keep out dust and moisture and to retain the lubricant, the felt seals being readily removable to permit of renewal of the lubricant and examination of the inner parts of the bearing when desired.

* Chief Engineer.



"XLS" series bearing.

BEARING STANDARDIZATION

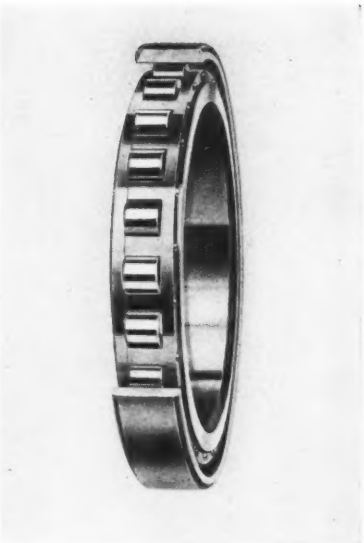
In the early days of aircraft engine and accessory design it was found that the existing standard metric series of bearings did not provide the necessary lightness and compactness. As a result, bearings of individual design were applied and soon a great conglomeration of sizes and types of special bearings was developed in order to obtain reduced weight. Recognizing the need for a uniform and properly designed series of extra light precision bearings, the "XLS" series of ball bearings and the "RXLS" series of cylindrical roller bearings, both of which are in wide use today, were introduced. These bearings are made to inch instead of metric dimensions and are made to tolerances comparable with those of existing metric series types. They represent the maximum possible lightness and compactness consistent with minimum distortion of the bearing rings and ability to operate at high speed.

TURBINE BEARINGS

With the advent of substratosphere flying and the new interest in the turbo-supercharger, original experience dating back to the early days of the Moss high-speed centrifugal type supercharger, enabled the quantity production of precision cylindrical roller bearings as required for use at the turbine end of these units. These bearings receive a special treatment throughout in order to withstand the high exhaust temperature involved and to permit them to be operated at the abnormally high speeds required.

HIGH-ALTITUDE DEVELOPMENTS

High-altitude flying has also presented another problem—the freezing of controls due to the hardening of the lubricant as prepacked into control ball bearings. The Research Division, as a result of extensive cold-box testing, was able to be of considerable assistance to the grease manufacturers on this particular problem so that an acceptable extremely low temperature grease could be obtained. In addition, the company has cooperated with the various Government laboratories in establishing tests for bearing lubricants to determine their suitability under high as well as low temperatures.



"RXLS" series bearing.

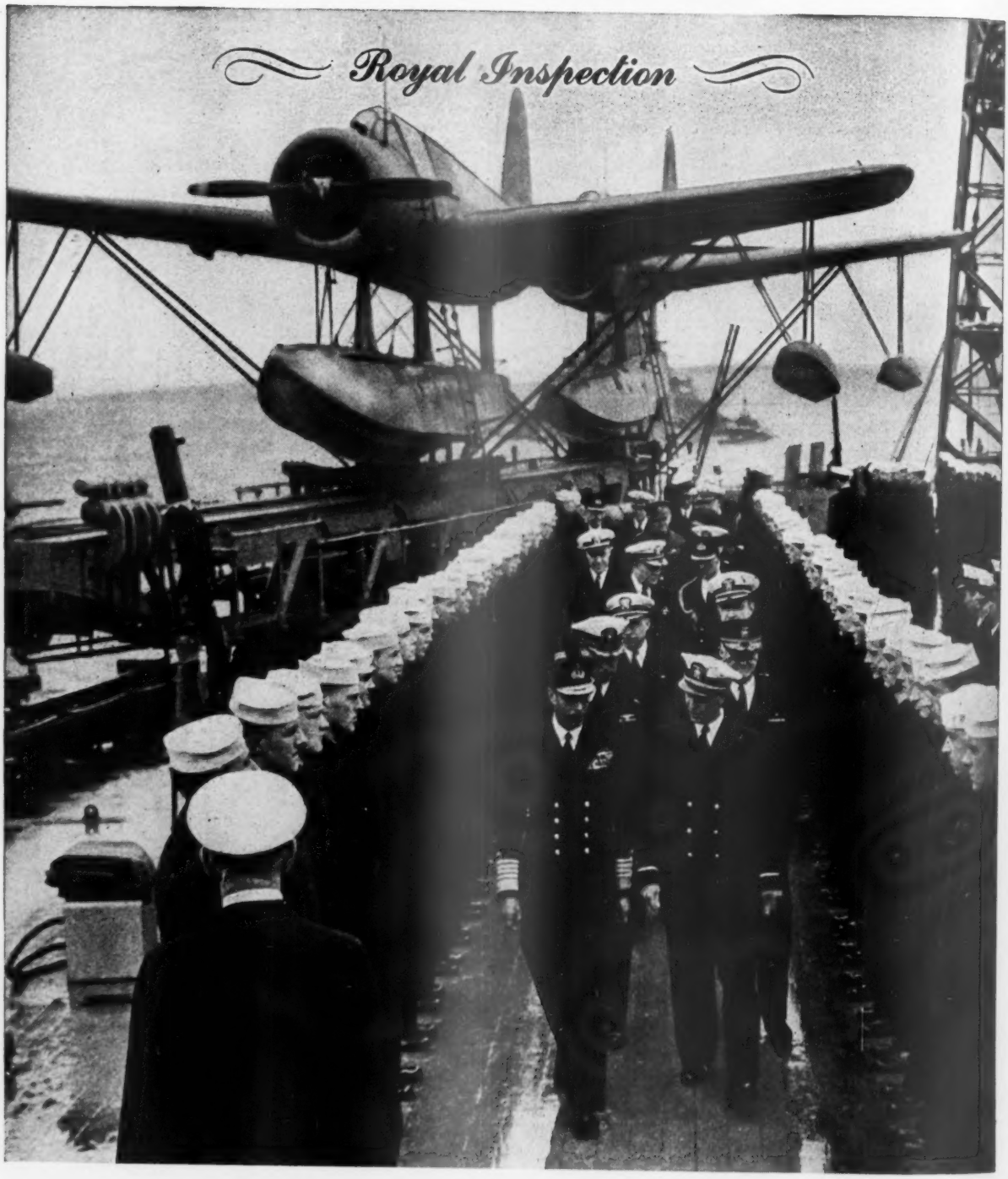
INSTRUMENT PROBLEMS

The increasing demand for the more sensitive operation of aircraft instruments has called for small ball bearings with a minimum of friction and with freedom from so-called "stickiness," particularly where these bearings are used under conditions of low torque or turning effort as for example, in gyroscope gimbals, pilot valve units, self-synchronous motors and the like. New designs of bearings and ball separators have, with other individual characteristics, enabled the development of bearings to meet these new and more rigid requirements.

Undoubtedly new and larger ships, higher flying speeds and higher ceilings will present new problems to the bearing manufacturer but with past experience as a basis, combined with new and active engineering research, it is safe to say that these new problems will be satisfactorily solved.

EDO FLOAT GEAR

STANDARD THE WORLD OVER



★ ★ ★ ★ Edo manufactures single and twin float gear for military aircraft. Complete technical data and advisory engineering service available. Edo Aircraft Corp., 413 Second Street, College Point, N.Y., U. S. A.

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The PESCO Pressure-Loaded Gear Pump

JAY M. ROTH*

ONLY A FEW YEARS AGO aircraft hydraulic systems were the exception rather than the rule. Then, gradually, aircraft designers found that they could save weight by hydraulic actuation of the landing gear, even when an electric motor-driven pump was used. Firm establishment of these advantages led to other applications of hydraulic mechanisms to save weight and cost.

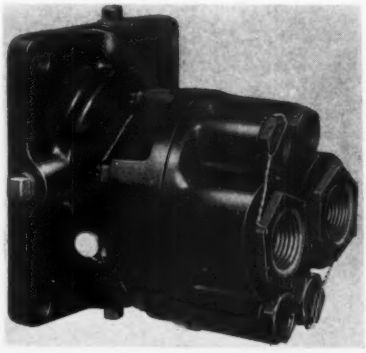
The Engine-Driven Hydraulic Pump

Eventually, a more extensive hydraulic system made desirable the use of an engine-driven hydraulic pump. It soon became apparent that hydraulic line loss was an appreciable factor in extensive hydraulic systems. The use of larger lines increased installation weight, so the logical step was to retain the same size lines and increase the system pressure as long as this could be done without increasing the wall thickness of the lines.

This resulted in a requirement for engine-driven pumps to operate at 1,000 lbs. per sq.in. intermittently, some unloading device being used in the system which would permit the pump to circulate oil under no pressure or in some cases under a pressure of 100 to 200 lbs. per sq.in. for operation of the automatic pilot when the 1,000 lbs. per sq. in. were not required for landing gear or flap operation. Since the high pressure was used only intermittently, aircraft designers felt justified in asking for slightly over 1,000 lbs. per sq.in., and in many cases they have pushed the maximum system pressure for short periods to 1,200 lbs. per sq.in.

Piston-Type Pumps

Extensive investigations into the possibilities of piston-type pumps were made by aircraft and accessory manufacturers. In general, the results indicated that the piston pump involved complicated mechanisms, difficult to fabricate and susceptible to rapid wear in service. The research staff of Pump Engineering Service Corporation had, in the meantime, carried out a parallel development, investigating the possibility of operating gear pumps at higher pressures. The advantage of the gear pump in simplicity is obvious. Requirements for performance at speeds from 750 to 4,250 r.p.m., together with the ability to use lighter viscosity oil for extreme cold conditions, present a difficult pump problem.



PESCO pressure-loaded hydraulic pump.

Gear Pump Losses

An analysis of gear pump losses indicated that the principal loss was leakage from the pressure to the suction side through the end clearance. If the clearance could be eliminated, the principal internal leakage would be eliminated and the performance would thereby be greatly increased. Eliminating the end clearance is practically what the PESCO research staff accomplished when they arranged the bushings that contact the faces of the gears in such a way that they were exposed to hydraulic pressure in just the right proportion to hold the bushings against the gears. This arrangement is called the PESCO Pressure-Loaded Gear Pump. The volumetric efficiency of the pressure-loaded gear pump is slightly above 90° per cent at 1,500 r.p.m., although the displacements of the two units are identical. This increase in performance is obtained with no practical increase in power required.

Altitude Tests

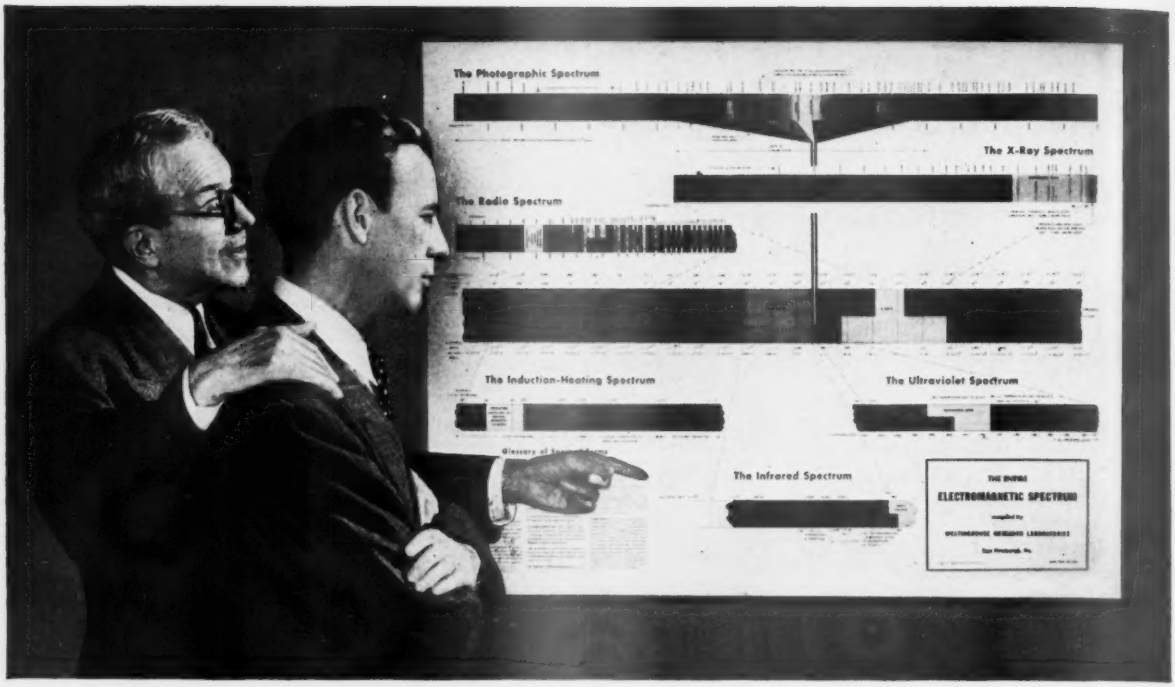
Simulated altitude tests in our laboratory showed another important advantage of the pressure-loaded type of construction which was rather unexpected. At high altitudes, when a gear pump is running at high speed, the absolute inlet pressure will be low, so that the spaces between the teeth will not have time to entirely fill with oil. When this partially filled space is carried around and suddenly exposed to the discharge port, a back flow results. On conventional gear pumps this is so detrimental that the absolute inlet pressure must be maintained above 15 in. Hg to prevent rapid erosion of the bronze bushings. With the pressure-loaded pump the bushings are held against the gear faces by a slight hydraulic unbalance, and this apparently absorbs most of the shock resulting from the back flow occurring when the pump inlet is starved.

The Pressure-Loaded Pump

The pressure-loaded gear pump gives excellent volumetric efficiency, superior low-speed performance with low-viscosity hydraulic fluid, and superior altitude performance because of its freedom from erosion. In addition to these desirable performance features, the endurance characteristic of this design is such that after a 550-hour endurance test conducted to Army Air Force specifications, the capacity of the pump will usually show about a 2 per cent increase and the general performance will be equal to the performance obtained before the endurance test. The reason for this is that any slight wear between the gear and the bushing is taken up by the pressure loading that holds the bushing against the gear with a force sufficient to permit only a slight oil film for lubrication between these two parts. This same feature also accounts for the good performance of the pump at temperatures down to −60°F.

It might well be expected that aircraft designers will consider the use of still higher pressures for future aircraft. However, the maintenance problem will be increased because of the greater difficulty of preventing leakage and the greater strain placed on the fittings and tube flares. It is therefore believed that the trend in hydraulic pressures will swing first toward 2,500 to 3,000 lbs. per sq.in. and then, because of maintenance troubles with the system, swing back to 1,500 to 2,000 lbs. per sq.in. as maximum pressure even for intermittent use.

* Chief Engineer, Pump Engineering Service Corporation Division, Borg-Warner Corporation.



"The Invisible Rainbow that benefits all mankind"

When you look at a rainbow in the sky, you see nature performing a fascinating experiment in optics. Tiny drops of moisture, acting as prisms, have broken the sunlight into its component parts.

The familiar white light we know as sunlight is really a combination of many rainbow bands of color, making up the visible portion of the Photographic Spectrum.

But there's another rainbow in nature . . . an *invisible rainbow* that benefits all mankind.

This is the complete *Electromagnetic Spectrum*, with bands of radiation that stretch out in an infinity of wave lengths on both sides of the Photographic Spectrum.

• • •

To the right of the Photographic Spectrum lie the shorter wave lengths of the *Ultraviolet Spectrum*. Here we find the

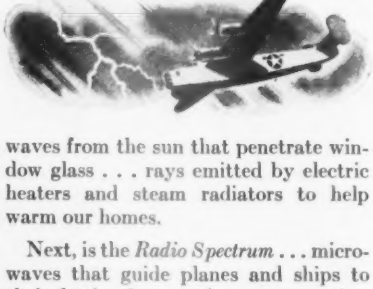
invisible radiations that make fluorescent tubes glow . . . erythemal rays that tan the skin . . . bactericidal rays that kill air-borne bacteria.

Further to the right is the *X-Ray Spectrum* . . . still shorter radiations that science has harnessed to diagnose and heal many human ailments . . . rays that penetrate heavy armor plate.

At the very end of the scale are the *Cosmic Rays* . . . unknown, mysterious cosmic particles that constantly bombard the earth.

• • •

To the left of the Photographic Spectrum are the longer wave lengths of the *Infrared Spectrum* . . . invisible radiant heat



waves from the sun that penetrate window glass . . . rays emitted by electric heaters and steam radiators to help warm our homes.

Next, is the *Radio Spectrum* . . . microwaves that guide planes and ships to their destinations . . . longer waves that bring us radio and television entertainment.

And finally, the longest waves of all, the *Induction-Heating Spectrum* . . . extensively employed by industry in the annealing and heat treatment of metals.

• • •

Westinghouse Research Engineers have played a major part in exploring and putting to useful work the myriad radiations in the Electromagnetic Spectrum.

As a result of the "know how" gained through years of experimental work in the Westinghouse Research Laboratories, these scientists have prepared a full-color chart which illustrates and explains every phase of the complete Electromagnetic Spectrum.

How to get this fascinating chart

The Electromagnetic Spectrum Chart, size 30" x 40", lithographed in 8 colors on heavy linen, is now offered to engineers and scientists for only $2, postage prepaid. Address: Department 6N-17, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Westinghouse

. . . MAKING ELECTRICITY WORK FOR VICTORY

The Pure Oil Company

W. B. ROSS*

THE PURE OIL COMPANY laboratories have been actively engaged over a period of years in the investigation of problems directly connected with the aviation industry and have made valuable contributions toward the industry's development. The Chemical Research Laboratory and the Mechanical Laboratory have cooperated in the work. These two groups have been endeavoring to provide methods and products, both from the refining and manufacturing points of view as well as the practical application of such products. Certain projects are, of course, not available for contemporary discussion.

It will be noted in the résumé following that some of the products mentioned are not concerned directly with the performance functions of aircraft engines, for the research staff has also been engaged in an advisory capacity with many of the producers of aircraft engines in an effort to ease machining problems and make recommendations calculated to speed production.

RECENT DEVELOPMENTS

Specifically, the following list will indicate some of the projects in which The Pure Oil Company has been interested and has actively engaged in during the past few years.

Lubricating Oils

High-grade lubricating oils have been developed and are being manufactured from the famous Cabin Creek crude oil which have been thoroughly tested and approved in accordance with the Navy specification for aircraft engine oils. These lubricants are highly refined Pennsylvania oils and are designed to withstand the service to which a good aircraft-engine oil is subjected.

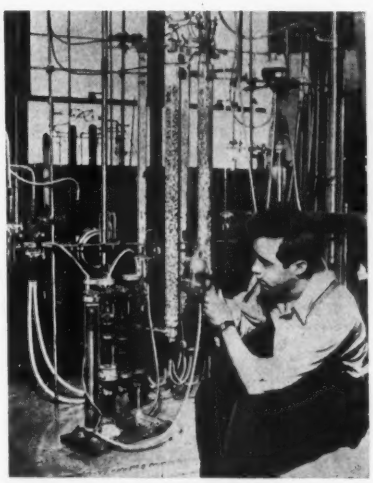
In accordance with the requirements of the Wright Aeronautical Corporation, aviation lubricating oils have been developed which have been tested under full-scale engine conditions and have received the approval of the Wright Aeronautical Corporation for use in high-output Wright engines. These oils are highly refined Pennsylvania oils, again manufactured from Cabin Creek crude, to which has been added a chemical compound designed to (a) reduce sludge formation and deposits and (b) aid film strength.

Special Greases

One of the problems which has been of great interest to the aviation trade has been the development of special greases for use in rocker arms of aircraft engines, as well as special greases and oils used in controllable and automatic-type propellers. Greases and other lubricants have been prepared to meet these demands.

Corrosion Preventives

When engine parts are fabricated, they are not usually used immediately and, if they are used immediately, sometimes the engine may stand idle or be shipped to some foreign land before it is put into actual use. During this time the freshly machined surfaces need protective coatings to prevent rusting and corrosion. Special antirust slushing compounds and oils have been produced which are used for this purpose.



Gas analysis at one of The Pure Oil Company's laboratories.

Committee Activities

Some of the committee activities in which The Pure Oil Company has been engaged, principally from an engineering point of view, have resulted in collaboration with engine manufacturers along the following lines.

(a) Investigation of the grain structure of copper lead alloy bearings with reference to determining their resistance to corrosion with various aircraft engine oils.

(b) The development of standard aircraft inspection forms whereby uniformity so that the rating of engines torn down for inspections can be reliably correlated. (This is particularly important in determining the effective overhaul periods for the engine, as well as determining the drain periods for the lubricating oils.)

(c) The development of shock absorber oils used in landing gear shock absorbers wherein lubricating oils of high stability and low pour points are required.

Pour Stability

One of the most important characteristics of an aircraft-engine lubricating oil where the engine is operated in cold climates is the pour point. It has been shown that oils in storage may become solid at temperatures appreciably above their A.S.T.M. pour point. The Pure Oil Company has developed a procedure wherein the pour stability of an oil (that is, its tendency to solidify in storage at low temperatures) can be evaluated together with its A.S.T.M. pour point. At present, The Pure Oil Company is engaged in discussions with the Military Service in an effort to improve the methods of specifying required pour points and pour stability for aviation lubricating oils.

Cutting Oils

There always has been active participation in the development of cutting oils and their application to machining operations. Pure Oil Company engineers are members of many committees whose primary function is increased production, whether by use of properly designed cutting oils, properly fabricated tools, or other items. They also act in an advisory capacity to the aircraft-engine manufacturers in an effort to standardize machine practice to effect better performance and production from cutting and grinding operations.

With the increased demand for aviation gasoline for many purposes, investigations were started which led to the production of several of the lower octane grades of aviation gasoline.

An active interest has always been maintained in all problems of the growing aviation industry, and it has been a company policy to assist wherever possible in obtaining rapid and accurate solutions of these problems.

* Chief Chemist.

New Finishes for Aircraft Plywood

NEW finishing systems for aircraft plywood are giving aircraft manufacturers new production problems. One of the major problems is that of effective finishes. Finishing systems must have minimum weight, production speed in application, resistance to the invasion of moisture, protection against extreme changes in temperature and durability against the ravages of vibration.

Research Report Issued

Ault & Wiborg Corporation has just completed a report on an extensive research into plywood finishing. The technical information in this report will be of interest to aircraft manufacturers who are turning to plywood.

Complete finishing systems have been developed and finished plywood has undergone severe tests, some of them for a period of several years. The systems are adapted to specific requirements differing for each of the woods used—birch, mahogany, fir, poplar, spruce.

Finishes Developed for Aircraft Manufacturers

The development of both materials and finishing systems has been conducted in close cooperation with some of the leading aircraft manufacturers.

The method of application can be varied to fit the production procedure and available equipment. The systems developed by Ault & Wiborg depend upon the nature of the wood used in fabricating the panels. A typical system might employ a clear sealer, a filler (on open-grained wood only), a pigmented sealer and finally a camouflage enamel. The problem of camouflage materials for all types of protective coatings has been a primary A & W project.

SEND FOR COPY OF THIS REPORT ON AIRCRAFT PLYWOOD FINISHES

A copy of the A & W Aircraft Plywood Finishes report is available to aircraft manufacturers or prime contractors who are directly involved in the production of plywood aircraft.

Write to Ault & Wiborg Corporation, Aeronautical Division, 75 Varick Street, New York City, New York.

IT'S A FIGHT TO THE FINISH!

Ault & Wiborg finishes are now being used for shells, bombs, gas masks, expeditionary containers, aircraft wiring systems, machine tools, camouflage purposes.

AERONAUTICAL DIVISION

AULT & WIBORG CORPORATION

A SUBSIDIARY OF INTERCHEMICAL CORPORATION

Contributions of the Puritan Compressed Gas Corporation to Aeronautical Progress

G. W. LARSON*

IT HAS BEEN STATED that one of the most important physical variables which affect the human organism while in flight in the modern commercial airplane appears to be the physiologic and psychologic impairment resulting from a lack of oxygen available for the organism at high altitudes.

The literature reveals that the early balloon ascents by the meteorologist Glaisher and the balloonist Coxwell (1862) and the French scientists Croce-Spinelli, Sivel, and Tissandier (1875) first called attention to the striking symptoms of diminished oxygen pressure on the human body and mind. It has been noted further that as early as 1878 the contention was made that the important factor in high altitude which causes the abnormal symptoms in the organism is the diminution, not in the mechanical or total pressure, but in the diminished partial pressure of the atmospheric oxygen and the consequent decrease in the alveolar oxygen and oxygen saturation of the arterial blood. This contention has been verified on numerous occasions by other experimenters, and it is generally accepted that the ill effects of altitude are primarily due to the diminished oxygen pressure. It seems to be evident that a general physiologic and psychologic deterioration begins in the neighborhood of 35,000 to 40,000 ft.

Human development has, for the most part, taken place relatively close to sea level, although there are millions of people in mountainous regions who have become acclimatized to altitudes as high as 8,000 to 14,000 ft. Adjustment to sudden changes in physical environment is one of the amazing capacities of the human being. However, when a person, acclimatized to sea-level conditions, is transported by airplane to comparatively high altitudes in a relatively short period of time, even though the altitude is maintained for short duration, it cannot help but have effect on various organic functions.

The Puritan Compressed Gas Corporation, having pioneered and specialized in the manufacture of medical gases and related items of equipment, was sought as a consultant by commercial air lines when their activities progressed to the point where it was found desirable at times to fly at altitudes such that supplemental breathing oxygen was necessary during the course of regularly scheduled transport service. It was felt that the advice of experienced medical oxygen engineers would be of inestimable value to the air lines in their selection of equipment necessary to regulate the oxygen for breathing purposes and to prepare oxygen gas suitable for inhalation at high altitudes.

To meet these original requirements, oxygen such as is used for medical purposes was supplied, and equipment similar to that used in hospitals was selected. Thus the air lines were placed in a position to take care of emergency needs and to experiment further in order to establish more exacting specifications. It was in this latter connection that the Puritan Compressed Gas Corporation engineers were in a position to cooperate with the medical and engineering departments of the air lines in developing apparatus designed not only from the standpoint of a company that has had nearly 30 years experience in the manufacture of gases and related equipment but also from the standpoint of the specialized aviation industry.

Extensive research was undertaken in determining the theoretic amounts of supplemental oxygen needed by the average individual at the standard altitudes of flight attained by commercial air lines and also, through theory, the type of equipment that would be required to furnish the proper amount of oxygen at the known altitude of flight. Upon completion of this study the equipment itself was developed, unique in design as it was, to function according to specifications. It was then tested and checked under varying conditions of flight, both simulated and real, as well as temperature, vibration, etc.

Puritan Portable Oxygen Unit. The kit contains a 22 cu.ft. capacity cylinder, a two-stage oxygen regulator, two plug-in valves with orifices to correspond to a 15-liter flow gauge; two nasal masks and bags. Total weight of complete kit is approximately 25 lbs.

Production by hand with consequent design changes progressed into quantity production to meet the increasing demands for equipment of this type. Efficient operation, lightness of weight, simplicity of design, and versatility of usefulness were factors considered in connection with all changes which finally resulted in standard apparatus universally acceptable.

Standard parts were employed wherever practical; the special parts include pressure control oxygen regulators, gauge dials calibrated in altitude, self-closing station outlets, bayonet fittings to open and provide flow of oxygen from the outlets, plastic connections of various types, visible flow indicators for oxygen supply lines, and thermoplastic nose mask (adjustable to fit individual face contours) with rebreathing bag.

With ever-expanding distribution came extended service facilities that now are provided from Coast to Coast.

The resulting contribution of these efforts is that specialized equipment is now available for scientific control and administration of supplemental breathing oxygen required at higher altitudes, with means provided for a centrally located oxygen supply, and manifold distribution with individual station outlets, as well as portable apparatus that can be used wherever needed to furnish oxygen for one or several individuals. A further result of this contribution is that military and commercial air lines of the United States and others of the United Nations were able to fly consistently at higher altitudes with increased safety, as well as comfort, for both members of the crew and the passengers. Photographic mapping, as well as other kinds of aerial photography, also has been made possible at higher altitudes.

The experience thus gained, both by the manufacturer as well as the users, has been made available to the Army and Navy in the interests of the war effort, and the future of aviation.

* Chief Engineer, Aviation Department

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Ten Years of RCA Aviation Radio Development

H. M. HUCKE*

In 1918 military planes boasted a not-too-certain one-way radio communication with ground stations, and the ground-to-plane communication was limited practically to signaling by flares, cloth panels or vigorous waving of the arms.

Today global war demands that planes take off and reach any designated point day or night, winter or summer, regardless of rain, snow, or fog. That they can and do meet these demands is in considerable part due to the remarkable improvements made in radio communication during the last ten years.

During those ten years (since the day in 1932 when the RCA Manufacturing Company took over the direction of the aviation-radio activities of the Radiomarine Corporation) RCA has continuously combined intensive field and laboratory research in the cooperative development of a number of important improvements in the scientific and practical use of aviation-radio equipment.

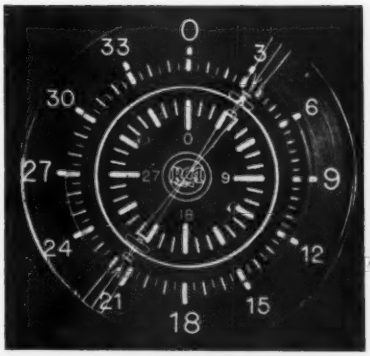
Package Merchandise

One of the early and extremely practical innovations introduced by the RCA Manufacturing Company was the supplying of aviation radio equipment for private aircraft as "package merchandise." Thus a buyer not only acquired a radio receiver but was also supplied with all controls, interconnecting cables, plugs, antenna accessories and proper instructions for installation. Prior to that time the light plane buyer found it necessary to purchase a number of different items from several manufacturers before he was able to make a practical installation.

The Streamlined Egg

One of the early projects carried out in May, 1936, was the testing in wind tunnels of various kinds of loop antennas. This resulted in the adoption of the "Streamlined Egg" type of loop for the RCA AVR-8 type of radio compass. The quantity production of this compass and its wide distribution over the country paved the way for the wide adoption of the streamlined, completely enclosed loop housing.

* Manager, RCA Aviation Radio Sales.



Electronic indicator of the RCA Omni-directional Radio Range Receiver. Aircraft direction is indicated by a break in the inner circle at 34°. Outer numbered scale is adjustable to correct for wind drift.

The metallic shielding of loop antennas for direction finders was suggested as early as 1912 and was used by the Radiomarine Corporation of America on marine vessels in the early 1920's. As a result of these installations, operating personnel discovered that the shielded type of loop would allow reception in snow storms when open wire types of antennas were useless. This information was supplied to TWA and United Airlines, who incorporated the idea in the shielded loop antennas which are now used on all domestic air lines for reducing the effects of snow static.

Antenna Reel Improvements

Flight experience with antenna reels on light airplanes resulted in the development of the AVA-41A Antenna Reel, which introduced two innovations of great benefit to pilots. The first of these consisted of running the antenna reel out of the top of the airplane instead of the bottom and allowing the antenna wire to pass over the top of the rudder through a suitable guide. This provided transmission on the ground while taxiing, a condition that could not be obtained by previous reels without installing an additional fixed antenna on the airplane. The second innovation was the free wheeling brake, which allowed the antenna to be released without winding it out by merely turning the hand crank half a turn.

Direction Finder Improved! New Tubes, Ignition Shielding

A cooperative development between 1936 and 1939 with the Sperry Gyroscope Company resulted in the introduction of the automatic aircraft direction finder. This "ADF" overcame many of the previous limitations of aircraft direction finders and was soon adopted by most of the commercial and military services.

In 1940 the RCA Manufacturing Company adapted the Omni-directional Range to use on the ultra-high frequencies and conducted the first practical demonstrations of this navigational device in this country.

The development and mass production of beam power tubes, such as the 807, 6L6 and 815 by the Vacuum Tube Division of RCA, has been a major contribution to the high efficiency of American aircraft radio transmitters.

In 1941 the RCA Manufacturing Company applied their auto radio experience to aircraft and entered into a contract with the Stinson and Piper Aircraft Companies to supply their entire production of certain models with radio receivers which did not require shielding of the engine ignition system. The engineering of this type of receiver and its installation represented a distinct engineering advance and economic advance for the light plane owner.

New Trend in Receivers

In 1940 the first two-band five-tube superheterodyne aircraft receiver that could be mounted behind a standard aircraft A-N instrument hole was introduced. The great reduction of size in components and tubes in this receiver has begun a new trend in aircraft receiver design.

The use of very small tubes, such as the 9001 and 9002 recently developed, with their large saving in weight, will have a material effect upon future receiver designs.

What of the Future?

As for the future, RCA is engaged in developments that cannot, of course, be discussed now, but we may already predict that their effects upon aviation radio after the war will be considerable if not revolutionary.

Republic Steel Corporation

E. R. JOHNSON*

No summary of the technical contributions made by members of the research staff of Republic Steel Corporation during the past ten years would be complete without reference to at least a half-dozen research projects, all of which have had some influence on present-day aeronautical progress.

Since 1930 our laboratory has been engaged in what amounts to a continuous development of new analyses of stainless steels. This work has involved the study of hundreds of heats of experimental compositions made in small electric furnaces.

Welding and Corrosion

The welding of stainless-steel sheets has been another problem to which we have devoted considerable time. A difficulty encountered heretofore in the welding of stainless-steel sheets has been the carbide precipitation at the boundary between the hot and cold junctions during welding. This precipitation has been the cause of subsequent embrittlement of the part after it has gone into service. As a result of studies, commenced in 1933, the chemical composition of our stainless steel has been changed to prevent precipitation, and the welding technique itself has been altered to reduce the amount of area heated during the welding operation.

The prevention of pit corrosion in stainless steels is another research project we have been conducting. This work was begun in 1935. As a result of studies, the chemical analysis of the steel has been changed and also the timing of additions made in manufacture of the stainless steel to obtain a product that would be uniform throughout and have few, if any, particles that would cause pitting.

A study of Bright Pickling was instituted in 1935 which has borne some fruit. These studies have been concerned with the electrolytic pickling of stainless steels, using electrical as well as chemical cleaning of stainless steel after fabricating to obtain a bright finish.

Physical Properties

Research on improving the machinability and physical properties of stainless steels has been in progress since 1935. As a result of considerable study, it has been demonstrated that the machinability and physical properties of stainless steels can be improved by controlling the nitrogen content of the steel.

In 1936 a study of the rolling and heat-treating of structural parts of stainless steel was undertaken. These studies have been directed toward ascertaining the proper heat-treating procedure for each composition and shape to improve surface, quality, and physical properties of the stainless steel.

Problems involved in Bright annealing as a means of preventing the formation of hard scale normally produced during hot rolling have engaged the attention of other members of our staff since 1937.

Other laboratory studies, initiated in 1937, have been concerned with controlling the oxides and gases in stainless steel which affect adversely the piercing properties of stainless steels. While still in progress this study has already been productive of ways and means of limiting effectively these oxides and gases to amounts that do not interfere seriously with the success of piercing operations.

In 1938, a series of studies on the quality of ferro alloys was initiated. Specifications have been determined for ferro alloys from which steels can be manufactured which will be as free as possible from contaminating materials.

Prompted by certain rejections of finished parts, which had been traced to the refractories used in pouring aircraft steels, a study of these materials as used in sleeve brick and nozzles was undertaken in 1939. This research has been of great assistance in reducing the number of rejected parts produced.

Alloy Steels

Recently it has become necessary in the use of alloy steels for aircraft applications, which include engine parts, propeller unit assemblies, aircraft frame and undercarriage parts, to consider the possibility of reducing the alloy content to make the present alloy elements stretch further.

Programs have been instituted to experiment with the National Emergency substitute alloy steels to see whether they can be substituted for the materials now being used. Some of the results from the substitute steels have been entirely satisfactory. Other substitutions will depend upon complete service testing to make sure that the material will stand up under the severe stresses imposed upon aircraft parts.

The Central Alloy District of the Republic Steel Corporation has been making steel for aircraft application for a number of years. Steel for aircraft application means the best in quality. Only by keeping close records of the heats produced in our furnaces and insisting upon a careful handling of the steel through the mill operations could we be sure we were obtaining steel of uniform chemistry, cleanliness from a Magnaflux standpoint, freedom from other injurious defects, with a good surface and with a uniform response to heat-treating.

Electric Furnace Steels

As the tonnage of aircraft steels began to increase and demand for electric furnace steels increased, it became necessary to use larger furnaces and Republic installed a battery of six 50-ton electric furnaces. The making of aircraft steels in such large furnaces was necessarily a departure from the much smaller heats that had been made previously. These large furnaces have made it possible to produce the aircraft tonnage that is required today while keeping the end-point rejections relatively small.

Still larger furnaces have now been introduced, capable of charging 180,000 lbs. of scrap. A large tonnage of aircraft steel is now made using such electric furnaces. These charges are close to what may be obtained from the open hearth and illustrate the progress that has been made in the manufacture of aircraft steel in the past ten years. Practically all of the analyses used for the various aircraft parts can now be made in these larger furnaces.

Open Hearth Steels

It has also become necessary to begin to utilize the open hearth for production of aircraft steels for certain applications. Such applications include aircraft frames and strut members. In addition, there are certain nonmovable parts in engines which receive considerable forging and permit the use of open hearth steel. Other applications are being analyzed and, where possible, a number of these will be made using selected open hearth steel.

The production of aircraft steels has always received the utmost care. The secret of the success of such steels in various aircraft applications is due to the quality that has been maintained. This is especially true today when so many handicaps confront the steel producer in securing the various raw materials that go to make up a heat of steel.

* Assistant Chief Metallurgical Engineer, Central Alloy District.

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Send 10¢ for your copy of this fascinating 96-page history of aviation by Assen Jordenoff, author of "Your Wings", with illustrations of current fighting types. Airplane Division, Curtiss-Wright Corp., Buffalo, N. Y.
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When, in 1928, Curtiss-Wright built the first carrier-based Navy airplane designed specifically for dive-bombing, its then sensational ability inspired the name, "Helldiver." Today's Helldiver, the new SB2C-1, more than ever justifies its name—for its flashing speed and the greater destructive power of its heavier bomb load and deadlier armament have won the rating of "world's best" in the judgment of impartial authorities.

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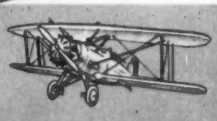
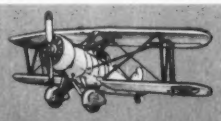
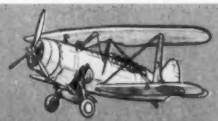
FIRST
Since the Birth of Aviation



1928 • First United States Navy Airplane built specifically for dive bombing tactics and carrier operation. Two fixed guns in upper panel and a rear swiveling gun completed the armament.



1933 • Further streamlined, using a twin-row radial engine for higher performance, the now famous Curtiss Helldiver was in use by both the United States Navy and Marines.



1937 • Many squadrons of these high performance SBC-3 dive bombers with heavy defensive armament and completely retractable landing gear saw service in the United States Fleet.

1939 • The SBC-4 powered with a Wright Cyclone, superseded the earlier type and excelled in performance. Planes of this model were still being delivered to the Navy in 1940.

Awarding Wings to Army Air Cadets

YOUR SON MAY BE our Boss

Somewhere high above a frenzied field of battle is the rhythmic roar of open throttles—the muffled sound of guns and cannon. Like miniature models, in a distant sky, a squadron of Army P-39 Airacobra pursuits piloted by American Youth battles it out against the enemy.

These are the battles for which we build. Battles that are our inspiration to make every Airacobra we build one of the world's most deadly single-engine fighters. We keenly feel the responsibility that rests upon us.

The success of our Army Air Force Pilots and every man in our fighting services depends upon mastery of the air. We at Bell Aircraft are serving these men with every ounce of ingenuity and skill at our command. They are entitled to our greatest efforts. *They* are the men for whom we work.

Among the millions of boys now serving in the fighting forces of our country you may have a son. It is our duty to serve and protect him. We are doing it by providing the mightiest weapon we know how to build. We are proud to have him as our boss.

And we shall be proud to keep him as our boss. For tomorrow, when victory is won these men and boys now in service will return to their places in industry and commerce. We look forward to serving them with the planes of peace in a new world of advanced aviation. © Bell Aircraft Corporation, Buffalo, New York.

Airacobras for victory—

FUTURE PLANES FOR PEACE

BELL *Aircraft*

PACEMAKER OF AVIATION PROGRESS

John A. Roebling's Sons Company

A. J. MORGAN*

THE JOHN A. ROEBLING'S SONS COMPANY, with main offices in Trenton, N. J., manufactures a complete line of aircraft cords, strands, and swaged fittings; wire rope and fittings; electrical wires and cables; round, flat wires and specialties; and woven wire fabrics. It maintains one of the finest research and development laboratories in the world and has pioneered in the development of control cords for aircraft from Wright's Kitty-Hawk experimenting ground to the rigid requirements of present-day manufacturers. The regular routines of this laboratory include fatigue tests of control cords, metallurgic research, studies of used and new cords, stretch characteristics, temperature changes and their effects, results of changes in pulley size, etc.

During 1941, the Roebling Company introduced a new development in control cables known to the trade as "Lock-Clad." It was conceived by the Lockheed Aircraft Corporation to meet the requirements of military planes and was given exhaustive tests at the Roebling Research Laboratories for more than a year. This new type of control cable comprises a preformed cable to which is swaged a dural tube and was designed to minimize stretch as well as the tightening or slacking of controls due to extreme temperature changes. Its other purposes were to permit lower rigging loads, reduce flutter tendencies and maintain relatively low and uniform friction values in the control system. The smooth outer surface of the clad section and the complete sealing of all voids in the cable by the swaging process made "Lock-Clad" particularly well adapted for control cables passing through certain types of pressure seas on aircraft designed for high altitude flight. The safety features of a multi-strand steel cable is retained while at the same time lost motion and friction is materially reduced.

Figures 1 and 2 show the physical properties of "Lock-clad" Carbon Steel Aircraft Cord.

This year, the Roebling Company installed new, improved equipment for the manufacture of a full line of aircraft cord fittings and for swaging these fittings to control cords. Before the advent of swaged fittings, and the complete preinstallation assemblies of cord and fittings that they make possible, the conventional design of aircraft control systems, in many cases, called for literally building the air frame around the control system. Now, however, it is feasible to design aircraft to permit easy application of complete cord-and-fittings assemblies after the ship is nearing completion. Also, in the replacement of control cords it is possible to pull complete assemblies through the system, making it unnecessary to swage one end only and fit the other end of the cord by a splice or with comparatively cumbersome portable swaging equipment. With modifications of conventional aircraft design, these improved swaged fittings will thus help to speed victory now and lower maintenance costs when aircraft again take up their heavy and vital peacetime loads.

Another recent Roebling contribution to the aircraft industry is a prestressing rig design for aircraft cords, developed to meet the requirements of one of the world's great airlines that desired to do its own prestressing. This prestressing rig was designed to remove the constructional stretch in aircraft cord which, if not removed from the cord before it is installed, necessitates further adjustment of the control system even after a few hours' flight.

This simple, inexpensive prestressing rig design is offered to all control cord users who are doing a small volume of prestressing work. To aircraft manufacturers doing this work on a production basis, our engineers will be glad to assist in developing a suitable design. For those manufacturers prepared to use aircraft cord assemblies complete with swaged fittings, the assemblies can be supplied, prestressed so that the major part of the constructional stretch is removed.

In the electrical field, Roebling manufactures an extensive line of electrical wires and cables for aircraft, with rubber, plastic, or varnished cambric insulations for power, lighting and ignition circuits. These wires and cables are moisture, oil and gasoline resistant, and flame-retardant and can be made to special as well as standard specifications and to meet Army and Navy requirements. Other Roebling electrical wires and cables include galvanized aircraft cord trailing antenna, airport boundary and field lighting cables, parkway cables, magnet wires, weatherproof wires, building wires, communication and control wires and cables, and power cables.

The aircraft division of John A. Roebling's Sons Company is fully staffed with trained, experienced engineers who appreciate the aircraft manufacturers' problems. With a background of 100 years' experience in the manufacture of wire and cable, it is in an ideal position to work with aircraft manufacturers in the solution of today's perplexing problems.

* Chief Engineer, Wire Rope & Strand Division.

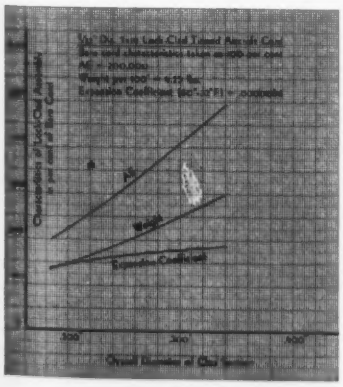


FIG. 1.

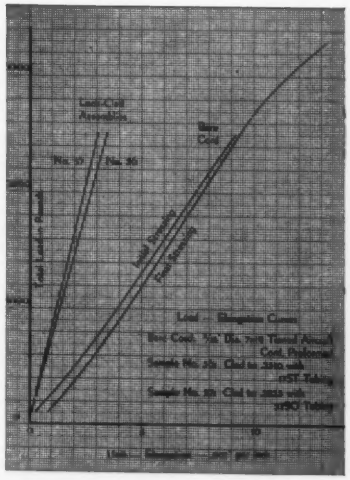


FIG. 2.

Between Rounds

Lawrance Auxiliary Power Carries on—

EXTENSIVE patrols required of long-range aircraft of the U.S. Navy mean many days away from the home base. Refueling stops at make-shift bases become necessary. It is here on the water, when main engines are idle, that America's patrol bombers rely on Lawrance Auxiliary Power Plants to supply continuous, dependable electric power for main engine starting, radio, lights, heat, galley hot plates and emergency operation of protective armament. Instantly available, whether afloat or aloft, these air-cooled engine auxiliaries add flexibility and fighting effectiveness to over-ocean patrol units of the Allied air forces.

Lawrance

ENGINEERING AND RESEARCH CORP.

LINDEN, NEW JERSEY

Simmonds Aerocessories, Inc.

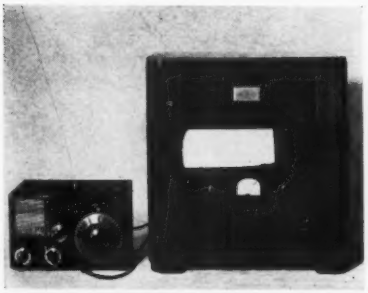
WILLIAM J. MORRISON*

IN THE FIELD of engineering aeronautical accessories and equipment, Simmonds Aerocessories, Inc., although comparatively young in this country brings to the American aircraft industry a wealth of experience gained through the close association of its engineering staff and management with Simmonds companies in England and other parts of the world.

The first company bearing the Simmonds name was established in England in 1930 by Oliver E. Simmonds, the well-known British industrialist, and now Managing Director of the English company, member of Parliament and chairman of the Parliamentary Committee for Air Raid Precautions. Today, this company is one of the leading English manufacturers of aircraft accessories and has a personnel of many thousands of skilled workers. The American company of which William R. Enyart is the president, was established in 1936 on an experimental and developmental basis with production begun in 1938. An associated Simmonds Company is located in Australia, and at the outbreak of the war similar units were in operation in Poland and France.

Simmonds in this country is a wholly American corporation, its connection with the other companies being simply the cross licensing of patents and the pooling of engineering experience.

It has been said that a great many British bombers, fighters, and trainers are equipped with one or more Simmonds products. While there has not yet been time to make possible the same wide use of Simmonds products in our own air forces a number of leading American military planes, particularly the bombers and fighters, now carry Simmonds equipment.



Receiving apparatus used with Simmonds Chronometric Radiosonde, which utilizes time measurement in securing and transmitting weather data.

All Simmonds products for American use are manufactured in this country. In addition to manufacturing products that have been developed and tested by wartime use in England, Simmonds is producing aircraft accessories developed in America, such as the Simmonds-Benton spark plug, the chronometric radiosonde, the Simmonds-Prentice rod end and other items.

The flexible push-pull control, manufactured under the name of the Simmonds-Corsey Control, is an example of a product developed in England which has been successfully adapted to American purposes. Widely used on R.A.F. planes, this control is now installed on a number of American and Canadian military planes. The Simmonds-Hobson induction pressure (boost) control, which provides mechanical control of induction pressure on supercharged engines, is another example of a Simmonds product that has been perfected through applications in English aircraft.

The chronometric radiosonde is an example of a Simmonds product developed entirely in this country. This radiosonde resembles other types in using a small balloon to carry aloft recording and radio transmitting device, but it differs from other types in that it utilizes time measurement in securing and transmitting all data. Variations in temperature, humidity and atmospheric pressure are recorded by variations in the spacing of time signals, transmitting these signals by radio to a receiver on the ground. Calibrated mechanically and directly, the chronometric radiosonde eliminates the element of human error, which is a factor when calibration has to be calculated.

The Simmonds-Benton power plug has established a record of service and dependability in extensive use in private and commercial planes and since the war, in Fairchild and other trainer planes.

In the field of hydraulics for airplane applications, Simmonds has pioneered in a number of respects. The Simmonds-Olaer hydraulic accumulator is an air-loaded fluid pressure storage tank which provides stored power to be called upon for auxiliary and emergency purposes. At present, work is being carried on preliminary to the installation of a complete high-pressure hydraulic system in a military aircraft.

With its production facilities expanded many fold to meet wartime requirements, Simmonds is concentrating on turning out the most vitally needed of its list of products. This includes, in addition to the items already mentioned: quick-disconnect units, clips, rings and fasteners.

To meet the needs of wartime production, Simmonds now has on its engineering staff a group of men with experience and outstanding reputation in a variety of fields. Chief Engineer is John W. Overbeke; Design Engineer for Hydraulics, E. M. Greer; Design Engineer of Mechanics, K. V. Hackman; Chief Instrument Engineer, L. A. Weiss; Design Engineer—Ignition, J. E. D. McCarty.

* Chief Field Engineer.

William R. Enyart, President and General Manager.

John W. Overbeke, Chief Engineer.

Just by KEEPING WELL

You can help win this war!

"Wave goodbye to Dr. Cross, darling"

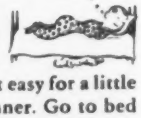
FOLLOW THESE 5 RULES

Memorize these five keys to good health. Follow them carefully — for your own welfare and for victory.

1. Eat Right

Milk, butter, eggs, fish, meat, cheese, beans and peas, fruit, green leafy vegetables and the yellow ones, whole-grain or enriched cereals and bread — these are the *key* foods. Eat plenty of them. *And* eat 3 meals a day!

2. Get Your Rest



Regularity counts most. You can't catch up on *lost* sleep or *missed* relaxation! Try to keep on a regular schedule every day. Take it easy for a little while after lunch and dinner. Go to bed on time, get up on time.

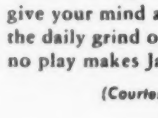
3. See Your Doctor Once a Year

You have your *car* checked and serviced every thousand miles. Do as much for your body. Physicians can *prevent* many diseases and illnesses for both children and grownups nowadays. Give your doctor a chance *now*, BEFORE you get sick. Go to see *him!*

4. Keep Clean

Plenty of baths, lots of soap. Clean hands, clothes, houses, beds! Get fresh air, sunshine. Drink lots of water.

5. "Play" Some Each Day



Romp with the family, visit with friends, take walks, play games — or do whatever you like to give your mind and body a change from the daily grind on the job. "All work and no play makes Jack a dull boy."

(Courtesy, Institute of Life Insurance)

THIS SPACE CONTRIBUTED BY THE BQ CORPORATION

SKF Industries, Inc.

S. F. WOLLMAR*

DURING THE FIRST WORLD WAR the Hess-Bright Manufacturing Company and the Skayef Ball Bearing Company contributed to the production of aircraft bearings. Following the amalgamation of these companies, SKF Industries, Inc., continued to share in the development of this field and today has assumed a principal part in war production of aircraft bearings. Ball and roller bearings used in aircraft engines must meet exacting requirements both in design and service. Standard commercial types are usually limited in use to component parts of auxiliary drives. The important powerplant applications, such as crankshaft, reduction gear, propeller thrust, rocker arm and supercharger, generally employ bearings that are special both in design and manufacture.

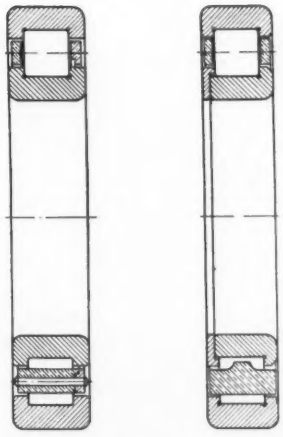
Special features in design are related to the combination of high load capacity and weight conservation in both the bearing and associated parts. Added considerations are involved in the adaption of the bearing to established procedure in the assembly and overhaul of the engine. Present-day bearing designs are such as to greatly facilitate the complete inspection of the bearing parts at overhaul.

CRANKSHAFT BEARINGS

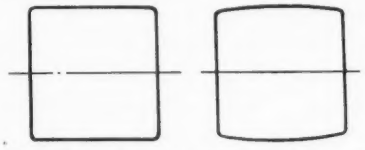
Antifriction bearings have been extensively used on the crankshaft of radial air-cooled engines. The cylindrical roller bearing, introduced in 1927, has largely superseded the ball bearing employed in earlier designs. This bearing has been progressively improved and refined in design in order to keep pace with the substantial increase in engine horsepower. Today the typical form of crankshaft main bearing is of the plate type construction, employing a land-centered one-piece cage and fitted with crowned cylindrical rollers.

PROPELLER THRUST BEARINGS

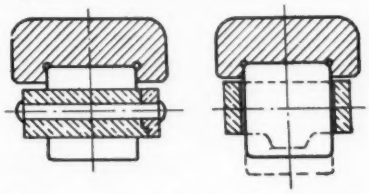
Deep groove ball bearings of the Conrad type have been extensively used for carrying the propeller thrust load in all types of aircraft engines. Since 1939, the demand for an increase in combined thrust and radial capacity, along with limitation of end play, has resulted in the development of the three-point type bearing with two-piece inner race. This bearing can be completely disassembled by removing the cage from the outer race, thus permitting a thorough examination of the raceways at the time of engine overhaul.



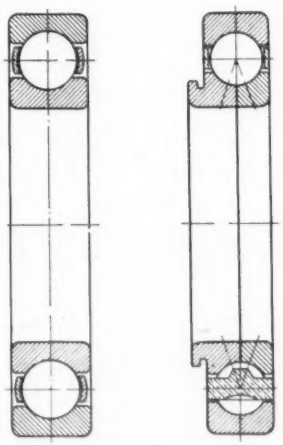
Conrad type (left). Plate type (right).



Straight (left). Crowned (right—exaggerated for reproduction purposes).



Riveted cage (left). One-piece cage (right).



Deep groove Conrad (left). Three-point propeller thrust (right).

Experience with the operation of engine bearings in service has conclusively demonstrated the importance of certain detailed considerations in their manufacture. The corner dimensions of heavily loaded bearings are stoned at their intersection with the bore outside diameter and face in order to prevent galling and scuffing of the mating surfaces. The bearing rings are subjected to a special stabilizing heat-treatment in order to control the subsequent tendency to growth when exposed to high engine temperatures. Finished bearing rings are submitted to an acid etch inspection for the purpose of detecting grinding temper, soft spots and other metallurgic defects.

MECHANICAL DETAIL

The past ten years has witnessed a progressive improvement in mechanical detail, associated with the design and application of valve rocker arm and supercharger bearings. It is evident that further improvement will be made in these units as the result of the extensive test experience that is now available.

A large number of ball and roller bearings are used in the manufacture of accessory equipment, such as starters, generators, magnetos, pumps and compressors. In some instances these units employ conventional bearings, but in many cases it is necessary to use special types that have been developed to meet particular requirements in design and service.

The bearing industry has been able to keep pace with development in the aircraft field only through close cooperation in the design, experimental and production stages. It has not been generally possible to directly utilize much experience gained in other diverse fields, and it has been necessary to develop practice formulated on the new and exacting requirements. SKF Industries, Inc., has been able to contribute to this enterprise by coordinating its resources with those of the companies who continue to sponsor the steps in progress.

* Executive Vice-President.

A PIONEER IN STEEL FOR AVIATION

BUDD

• Ever since 1931, when the Budd-built "Pioneer," world's first all-stainless-steel plane, started its tour of the world's capitals, Budd has been identified with aviation . . . showing the way to utilize the strength, corrosion-proof and fire-proof qualities of stainless steel in airplane construction.

• Today, thousands of planes are dependent upon parts and assemblies built by Budd of stainless steel.

• Budd's record in all fields of transportation—emphasizing safety, efficiency and long useful service—promises great things for the future.

EDWARD G. BUDD MANUFACTURING COMPANY

PHILADELPHIA, PA.

Socony-Vacuum Oil Company, Inc.

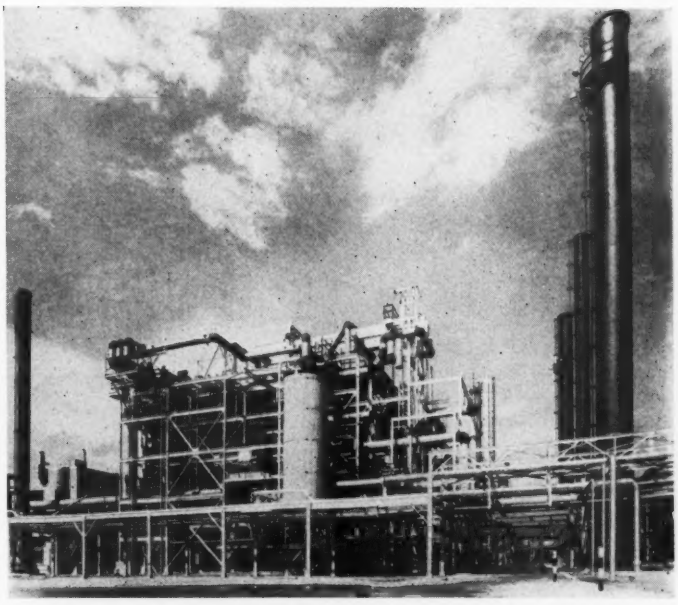
W. F. BURT*

TWO PETROLEUM PROCESSES that are now considered essential to the aviation industry are catalytic cracking for the manufacture of grade 100 aviation gasoline and solvent refining of lubricating oils for the manufacture of aviation lubricants. Socony-Vacuum has taken a major interest in both developments and contributed years of research to bring them to commercial scale. Ten years would not cover the development work undertaken by Socony-Vacuum on the Houdry process for catalytic cracking. An active research and refinery engineering program was arranged with Mr. Eugene Houdry as early as 1929, and pilot plants for the solvent treating of lubricating oils were installed in 1931.

The steps through which the catalytic processing of gasoline reached its present leading position cover six years of development work before the first commercial design was realized in full plant scale, and six additional years of improvements are now recorded. From a single-batch laboratory affair, the process developed around catalyst composition and mechanical structure, the engineering for multiple units to give a steady flow of product, a practical means for catalyst regeneration, and the many considerations for controlling heat losses and maintaining safe stresses.

Construction of the first 2,000 barrel-per-day unit in May, 1936, was followed by a 15,000 barrel-per-day plant in Beaumont, Tex., and seven additional units in succession thereafter. These catalytic processing plants form the backbone today of catalytic aviation gasoline manufacture. Following the development work and especially after the increased demand for aviation gasoline products, other companies built similar commercial units. Socony-Vacuum developments have continued, completing a continuous process called Thermofor Continuous Cracking to replace the batch system. The importance of the catalytic process in the present emergency is realized when practically all new refinery construction for expansion of aviation base gasoline production involves some variation of the original catalytic process.

Gasoline made by the catalytic process in the first refinery plant was soon directed into aviation usage. Unlike thermally cracked fuels, the catalytic product did not depreciate in knock quality in high-temperature aircraft engines. Furthermore, it was found to be almost the equal of conventional straight-run aviation gasolines in its freedom from gum-forming tendencies. Its use as a major base stock for aviation purposes seemed inevitable when its high tetraethyl lead susceptibility was realized. Aviation fuels made from catalytically cracked base stocks have combustion characteristics that make them highly desirable in our present expansion program.



Houdry catalytic cracking unit.

A majority of the aviation oils used today are made by solvent refining. Among the first to put solvent refining into large-scale manufacture of lubricating oils, Socony-Vacuum has contributed in a large measure to the quality of aviation engine lubricants. The solvent extraction of undesirable components is the most practical means for reaching the degree of stability so essential in aviation practice for minimum deposits and long bearing life. It has the further capability of raising the paraffinicity to a high value, whether or not the crude employed is from a Pennsylvania field. This high paraffinicity value, or viscosity index as it is better known, helps in no small measure to carry the extremely heavy ring loads on take-off and at emergency full-throttle engine power. Socony-Vacuum has also pioneered in the development and final full-scale testing of specially treated aviation oils.

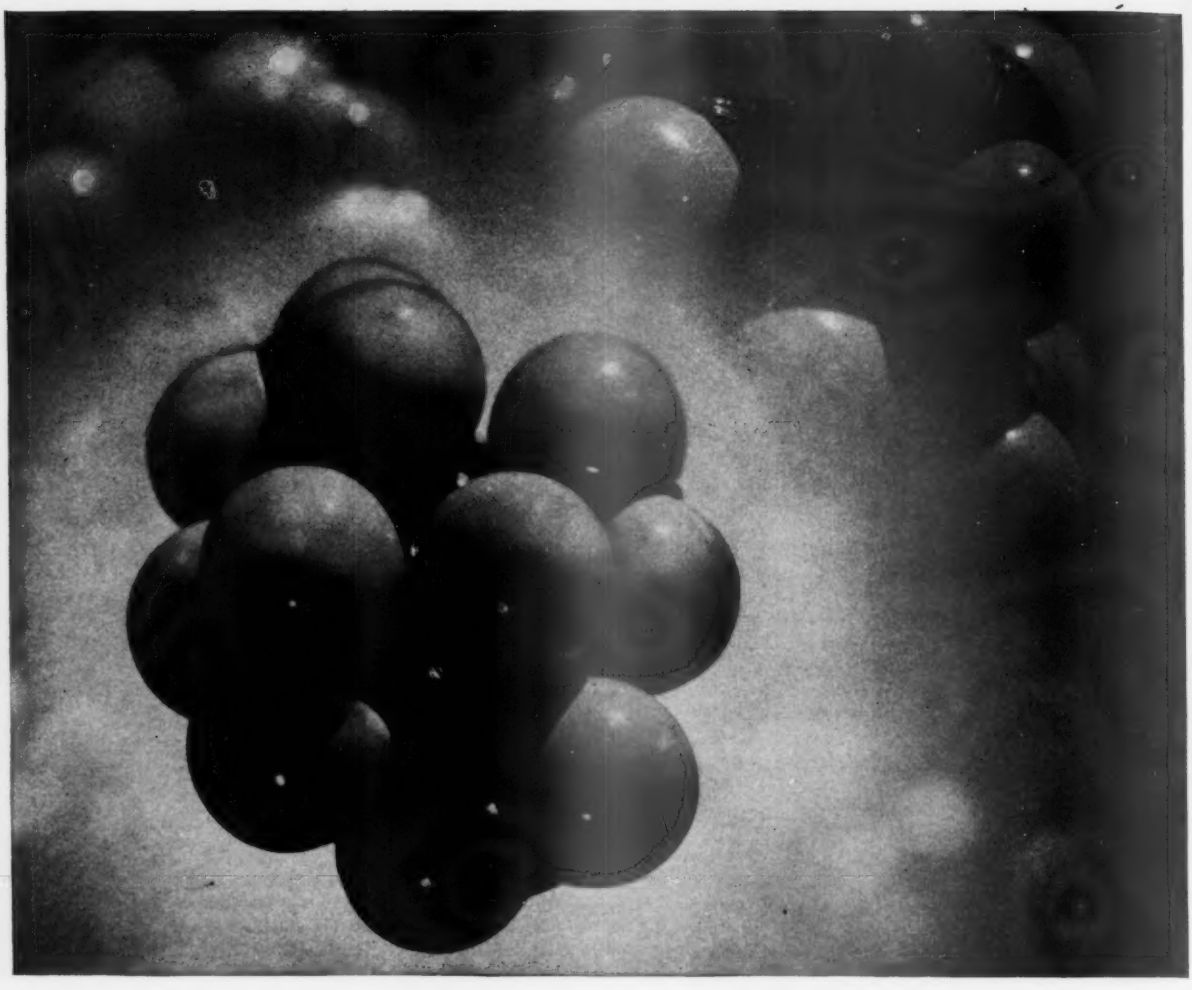
In the last ten years, a number of special products have been developed to suit the specialized needs of the aircraft industry. Some materials were developed for high-temperature operation, such as rocker arm grease, magneto bearing grease and similar products. Other materials have been developed so as to provide proper lubrication at both high temperatures and at the extremely low temperatures encountered under high-altitude flight conditions. Instrument oils and hydraulic fluids for automatic pilot, shock absorbers, gun turrets, bomb bay doors, wing flaps, and similar accessories are special products developed over a period of years to provide a complete line for this particular requirement.

Cutting oils designed especially for high-speed machinery of tough alloy steels, quenching oils used in heat-treating, and lubricants for the machine tools are among the many such products carefully developed to aid in the production of engines and planes.

With the expansion of the aviation industry over great areas the worldwide distribution facilities of this company have rendered a valuable service.

Present developments along a wide front are expected to serve the aviation industry in many new ways. Improved fuels and lubricants are speeding up production, reducing maintenance, and permitting marked advance in performance, all of which is made possible while greatly increasing production to keep pace with the times.

* Vice-President, Manufacturing.



BUILT-IN TAIL WIND

SHOWN ABOVE is an amazingly effective device for increasing the speed, cruising range and climbing ability of airplanes.

It is a molecule—represented by a chemist's model 100 million times life size—of neo-hexane, one of the modern synthetic products of the petroleum industry that far surpass gasoline as fuel for aviation engines.

The discovery of neo-hexane (known also as 2,2 dimethylbutane) was a triumph of the petroleum industry's peacetime search for more efficient fuels. Long before Pearl Harbor, the American oil industry had discovered and developed processes for manufacturing this and a number of other high octane blending agents so that today we are able to supply all planes of the United Nations with very high octane motor fuel.

The production of aviation gasoline is no longer a matter of simply distilling and cracking crude petroleum. It is a highly complex chemical art—a science of synthesizing special compounds that can be blended into fuels of predetermined characteristics.

Among the chemicals which give our aviation gasoline its high antiknock quality is Ethyl fluid. That is why Ethyl engineers cooperate with the petroleum industry in their search for better aviation fuels. And, since fuels and engines are so closely related in their development and use, we also do all that we can to be helpful in the development of engines which will best utilize these improved fuels.

ETHYL CORPORATION
Chrysler Building, New York City

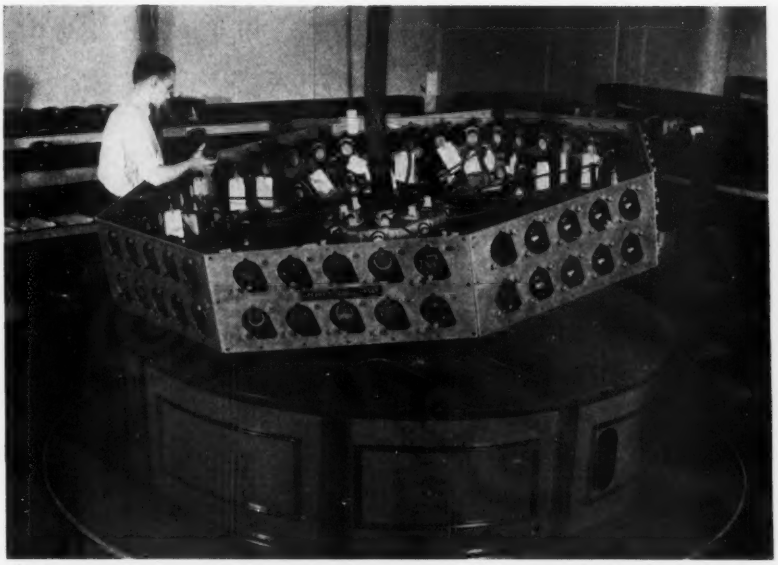
Manufacturers of Ethyl fluid, used by oil refiners to improve the antiknock quality of aviation gasoline.

Contributions of the Sperry Gyroscope Company to Aviation 1932–1942

PRESTON R. BASSETT*

A REVIEW of Sperry aviation activities for the last ten years is, of necessity, overshadowed by the fact that many of the company's developments began long prior to 1932 and actually represent a sequence of development which began in the period 1912 to 1914. Furthermore, certain achievements in connection with military and naval aviation cannot be described at present due to wartime restrictions.

Sperry aviation activities would normally fall under four heads: flight instruments; air navigational instruments, such as the automatic radio direction finder; landing systems for safe landing under conditions of poor visibility; and automatic pilots for aircraft. Actually, the classification given is an oversimplification, as there are various combinations of instruments in these categories, but it is useful for descriptive purposes.



This multiple test stand is used to simulate the motion of an airplane in flight and makes the simultaneous preflight testing of 80 Sperry artificial horizon and directional gyro units possible.

FLIGHT INSTRUMENTS

As a development that had its first intensive tests in the flights by Lt. James H. Doolittle in 1929, flights that inaugurated the modern era of blind flying, the Gyro-Horizon (originally called "artificial horizon") has undergone continuous refinement and standardization. This instrument, in combination with the Directional Gyro, is essential equipment on all naval and military aircraft, and there has been an enormous expansion in facilities for production of the Gyro-Horizon and the Directional Gyro. Detailed engineering improvements in the last ten years have included improved antivibration mountings, temperature compensated bearings, improvements in gyroscope design and characteristics, and improvements in the dials of the instruments.

The multiplicity of instruments facing the pilot of a modern completely equipped airplane led to work on the Flightray, a development that has been set aside during wartime. The purpose of the Flightray is to concentrate on a single dial those indications of direction, altitude, speed, and attitude of the plane, which are essential to flight. Indications of the instrument landing system can also be included in this centralized concentration of data. The indications are all presented as luminous traces on the target of a cathode ray tube which forms the dial of the instrument. Beginning with tests in 1937 and 1938, the Flightray has undergone continuous development until recently and has achieved a high degree of accuracy in centralized presentation of essential flight data.

INSTRUMENT LANDING

Although the Flightray has been made adaptable to any instrument landing system, the Sperry Company has continued work on an improved landing system that is to have a straight glide path, adjustable as to angle.

AIR NAVIGATION

The increased use of directional radio and the establishment of many radio beacons brought a demand for an automatic radio direction finder, and work on this was begun in 1939. By an ingenious arrangement of crossed loops the necessity for interpretation of the relative intensity of aurally received signals, with the dangers of inaccuracy which were always present, has been eliminated. The operator wears headphones to tune in on signals, but the directional indications, once the receiver is tuned to a station, are automatically shown on a conveniently located horizontal dial. The dial also has movable scales for magnetic and true bearings.

AIR GYRO PILOT

The gyro pilot for airplanes has a long and intensely interesting history, going back to Lawrence Sperry's work in 1914 and later experiments with the automatic control of aerial torpedoes in World War I and the years immediately following. The modern hydropneumatic gyro pilot was brought out in 1932 and was installed in a Boeing 40 of United Air Lines. In 1933 further improvements were made, and Wiley Post used the gyro pilot in his solo flight around the world. Refinement of design continued until, by 1939, more than 1,600 gyro pilots were in service. The gyro pilot has an important application in military and naval service, especially where precision flying is necessary, and intensive wartime development will have a significant influence on future civil applications of this equipment.

* Vice-President in charge of Engineering.

They work together better . . .
because they can talk together

In both the Coral Sea battle
And at Midway,
The Japs were robbed of a sneak attack
By scouting U. S. fliers,
Who reported back by radio.

Then Uncle Sam's carrier-based planes,
And land-based bombers
With perfect team work
Plastered the Jap task forces . . .
Giving special attention to
The enemy carriers.

And over the radiotelephones
Of our planes and ships
Came the phrase, "Scratch one flat top!"

The young American fliers
Were telling the world
Another Jap carrier
Had gone to the bottom!

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Is helping Uncle Sam
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On land, sea and in the air.

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IT&T

Associate Manufacturing Companies in the United States
International Telephone & Radio Manufacturing Corporation
Federal Telegraph Company

Thompson Products, Inc.

A. T. COLWELL*

OVER THE PAST DECADE Thompson Products has devoted considerable research to the development of alloys used in valves, valve design and the technique of manufacture. With the constantly increasing power being developed, the exhaust valve problem in particular has been one calling for careful analysis and study.

A method for depositing Stellite on seats with an automatic machine has been developed in collaboration with a manufacture of welding rod. This results in faster production and more uniformity than was possible with hand welding.

Electrolytic polishing of the interior of hollow valves in a specially designed fixture has been worked out at the Thompson laboratory. It has always been necessary to bring the interior of the hollow stems to a mirror finish. This has been done by polishing with several grades of abrasive cloths. As an added precaution electrolytic polishing has been added to the standard finish to remove the marks of the finest abrasives used.

In connection with valve work, an automatic, mechanical clearance regulator for valve lash has been developed and has successfully passed full-scale engine tests. This regulator makes with a complete adjustment for clearance each action of the valve, and it is accomplished during the period that the valve is on its seat. This mechanism should minimize one of the most troublesome problems of large-engine design—namely, an irregular heat pattern that necessitates various clearances throughout the engine with changing operating conditions.

* Vice-President.

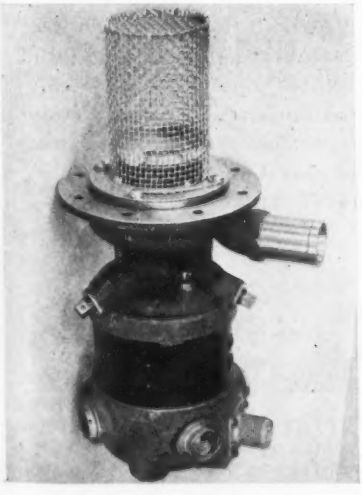

FIG. 1.

The Thompson fuel pump and booster pump has found wide use in aircraft fuel systems. The fuel pump is a vane pump which is nonpulsating, the blades working in a developed bore. By means of three through blades operating in a bore that consists of two circle arcs joined by parabolic spirals, the movement of the blades into the fluid at the intake side is always equal and opposite to the movement of the other blades at the discharge side. Freedom from pulsation and shock results.

The booster pump (Fig. 1) was developed to prevent vapor lock at high altitude and is of the centrifugal type, electric motor-driven, running at high speed. The throat of the pump is designed to expel vapor from the fuel,

FIG. 2.

allowing only liquid fuel to pass into the system. The pump maintains a pressure between its own discharge port and the engine-driven pump sufficient to prevent further vapor formation. It is being built in numerous types for both low-pressure and high-pressure carburetors and for external and submerged use. A two-speed type is in use which will serve as an emergency pump in case the engine-driven pump should fail or be damaged in combat. It is run at high speed for emergency use, developing enough pressure to serve high-pressure carburetors. For prevention of vapor lock at high altitudes the pump is switched to a lower speed. The booster pump is one of the units making possible high altitude performance in our planes today.

A series of quick-disconnect couplings (Fig. 2) has been developed. The principal feature of the coupling is the fact that there is no restriction in the flow position and that complete sealing of both ends of the line is obtained by a 90° turn. One of the problems encountered has been to find synthetic materials that would work satisfactorily below zero and in the hot oil range, but this has been successfully accomplished. The coupling has been designed to consume a minimum of space on the fire wall. Neighboring couplings do not interfere with the manipulation of any one coupling. Consequently, all lines can be brought through a wall within a small space. The time to disconnect an engine is reduced to a matter of minutes.

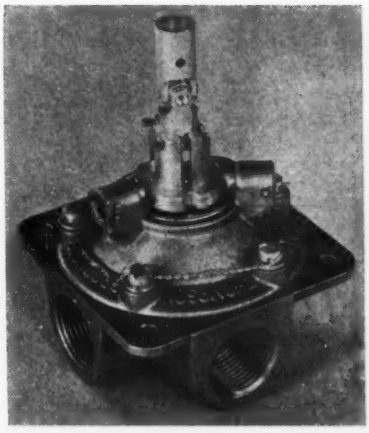

FIG. 3.

A fuel selector cock (Fig. 3) is now in production which allows the pilot to select fuel from any tank by the movement of a lever. The sealing and mechanical operation of the valve have been greatly improved and it is beginning to find wide acceptance.

An adaptation of the well-known electric-gathering method for forming automotive valves is producing exhaust-stack flanges from heat-resistant alloy tubing. The end of a relatively thin tube is electrically heated and upset. Both machining time and critical materials are saved.

The company's experience in precision machining and grinding, gained through years of work in valve manufacture has been put to use in the production of over 1,000 different engine parts. These hardened and ground parts range from cylinder bolts to propeller hub parts.

A cowling fastener which is positive in its action has passed Army tests and is in limited production.

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In commercial flying, American Airlines Flagships have been "at the front" with many outstanding transportation achievements.

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Recent Aircraft Developments of United States Rubber Company

H. L. HAYWARD

One outgrowth of the tremendous strides that the aircraft industry has made in the last ten years has been an increasing use of rubber products in airplanes. Hundreds of aircraft parts are made of rubber—both natural and synthetic. Over this period the entire rubber industry has concentrated research and development facilities to make possible larger, faster, safer, and more efficient airplanes.

The Bullet-Sealing Fuel Tank

Among the most interesting and important of these developments is the bullet-sealing fuel tank of which United States Rubber Company was the first producer in the nation. Developed from the same principle as the puncture-sealing automobile tube but employing special synthetic construction to resist the deteriorating effects of aromatic gasoline, United States Rubber Company is producing bullet-sealing fuel tanks in four plants. These tanks are of two types: one developed entirely by United States Rubber Company; and a second type, the Mareng cell, developed by The Glenn L. Martin Company and manufactured by United States Rubber Company.

In addition to these two types of permanent bullet-sealing fuel cells, United States Rubber Company engineered and is producing in large quantities a bullet-sealing jettison fuel tank to supplement the normal fuel capacity of our military airplanes. This tank is mounted outside the plane proper, is perfectly streamlined, and can be thrown off in combat. It considerably extends the effective range of our pursuit and fighter aircraft.

As a companion part to the self-sealing fuel cell, United States Rubber Company has produced a bullet-sealing fuel hose for complete protection of the airplane's fuel system. As a test of this hose one three-foot section was pierced by thirteen 50-caliber bullets with a loss of only a slight amount of the aviation gasoline passing through it. Many thousands of feet have already been installed in military airplanes.

Aluminum Substitute

The Company has also developed a substitute for aluminum for the construction of fuel tanks and other aircraft parts. This material, called C-102, is stronger per unit of weight than aluminum, is manufactured from noncritical materials, and is easily fabricated into units such as fuel cells. The material also has a big advantage in fuel cell construction of opening or "flowering" less than aluminum under bullet impact and thus makes easier the sealing action of the cell it encloses.

Tire Developments

Tire development has also matched airplane improvements. While not spectacular to the casual observer, improvements in tire construction such as shock-ply construction and rayon cord (both developed for airplanes by United States Rubber Company) have greatly increased tire strength while reducing weight as much as 10 per cent under former types of construction. Both features have made possible larger and heavier planes with higher landing speeds.

"U.S." airplane tire engineers assisted in the development of dual wheel and tire installations in aircraft—a development that promises greater usefulness for larger planes in the future.

Two new tire treads have materially improved airplane ground performance. "U.S." Block Tread has largely replaced plain treads for general use because of its improved stopping power on unimproved landing surfaces and longer tread life on all types of landing surfaces.

"U.S." Ice Grip tread, developed for use of the Army at northern bases, incorporates metal studs imbedded in its tread for increased brake action on snow- or ice-packed surfaces, an improvement that greatly extends the working radius of our military and commercial airplanes.

While airplane tires for both commercial and military use are still manufactured of natural rubber, it is interesting to mention that United States Rubber Company has produced 100 per cent synthetic rubber-treaded airplane tires that have given service in landings equal in hours to the best tires of crude rubber.

Conductive Rubber

Another rubber development of recent years has been conductive rubber—rubber that by the addition of chemicals *conducts* rather than insulates electricity. "U.S." had a large share in this development and for some time has been producing both auxiliary and main wheel tires of conductive construction that grounds the plane's accumulated charge of static electricity upon initial contact with the ground. This development has proved to be an advance in both safety and comfort.

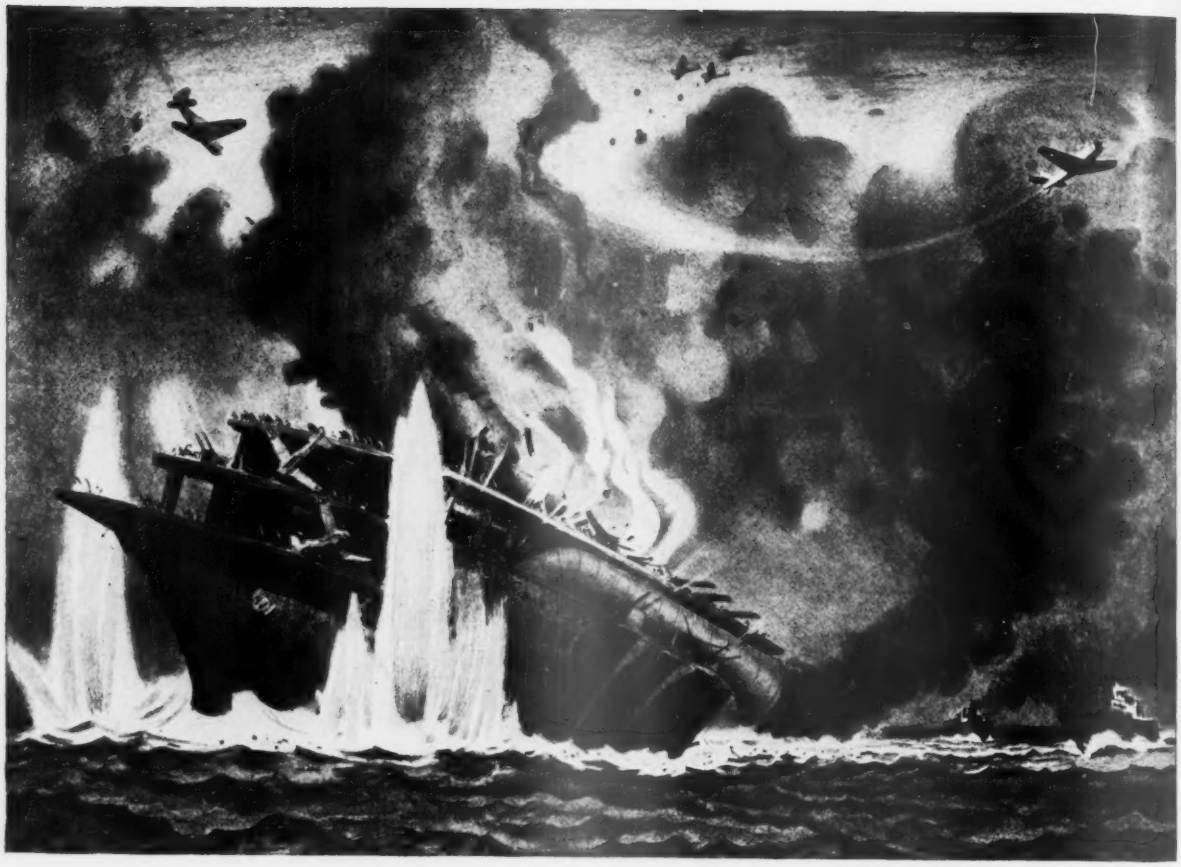
Recent Developments

Other aircraft developments over recent years by United States Rubber Company include research into aircraft vibration and dampening methods. As a result of this research, special lightweight rubber mountings have been developed which range in size from tiny ones for delicate instruments to large ones to support powerful motors. Cellular rubber, an entirely new form of rubber, is produced by United States Rubber Company in both hard and soft forms for mounting and supporting airplane fuel tanks and for light but strong vibration-absorbing bulkheads or panels.

A new type of rubber insulation has produced a wire of reduced diameter and weight for aircraft installations, and the Company has pioneered lightweight multiflex air ducts of heat-resisting materials for many aircraft purposes.

The Footwear and Clothing Division of United States Rubber Company was one of the first producers in this country of lightweight collapsible fabric boats for aircraft. These have already saved the lives of many men and are standard equipment on military and naval planes operating over ocean areas. Other developments of this division include specialized aircraft boots and shoes for many purposes.

For several years, the development of aircraft rubber parts has required considerable research into synthetic rubbers. Because of their superiority over the natural product in many important respects, synthetics have been used for some time in aircraft products such as fuel tanks and hose. Research within recent months has been intensified to the point that almost every aircraft rubber part can be duplicated in synthetic with no loss of quality, performance, or efficiency. With the tremendous acceleration of America's synthetic production program since the war, the aircraft industry is assured of a continued supply of rubber for essential parts.



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Westinghouse Contributes to Aeronautical Progress

V. J. KROPF*

THE AVIATION INDUSTRY is one of America's youngest industries but is rapidly reaching the position of the nation's foremost activity. The tremendous aeronautical progress achieved in recent years has been the result of long years of research and development on the part of the aircraft industry and also on the part of associated industries supplying integral parts and accessories for planes. Progress and developments in the electrical industry also have contributed much to the aviation industry in production methods as well as in actual aircraft design and operation.

Westinghouse Electric and Manufacturing Company has been interested in aviation for over 25 years, building not only electrical equipment of all kinds for planes and aircraft plants but also a variety of mechanical equipment for aircraft. Both ceramic and plastic materials have been developed for plane parts and accessories used by aircraft and engine builders. Metal alloys and equipment for heat-treating steels have been developed for aircraft-engine production, and various types of dynamometers have been designed for engine testing purposes. Distribution network systems have been laid out to insure continuity of electric power supply for aircraft plants and a multitude of electric motors, control equipment, transformers, switchgear apparatus and other electrical items have been applied for production purposes in plane factories. Main drive and power supply equipment for numerous wind tunnels have been completely engineered and built by Westinghouse for private aircraft companies, as well as various branches of the Government, educational institutions and research laboratories.

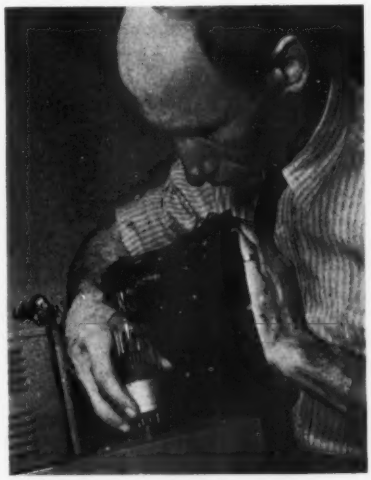
Aircraft accessories for producing electric power for the planes as well as facilities for controlling its distribution have been designed and manufactured in great quantities. Main engine-driven generators, aircraft voltage regulators and relay switches are supplying electrical energy on thousands of airplanes. Radio transmitters and receivers have made possible intercommunication between planes and constant contact with ground personnel in everyday circumstance. To meet Army Air Force requirements, various aircraft instruments have been developed and produced including ammeters, voltmeters, volt-ammeters, blind landing indicators, oxygen-flow indicators, temperature indicators, etc.

* Aviation Division, Westinghouse Electric and Manufacturing Company.

INSULATION DEVELOPMENTS

A new type of ceramic insulation material, known as Prestite, has been introduced and is being applied for use in aircraft ignition systems, spark plug insulator sleeves and magneto parts. Micarta products of all kinds have been applied to aircraft in various molded and fabricated forms and Micarta control pulleys for aircraft are being used in tremendous quantities. Circuit breakers, suitable for aircraft application, have been developed for control of the numerous circuits required on a plane eliminating the need for fuses. Westinghouse has brought out lighting equipment for aircraft with a broad line of apparatus, including airplane headlights, signal lights, spotlights, landing lights, fluorescent lighting, etc.

Electric power loads are still increasing in airplanes and development work on larger generators and motors, both alternating current as well as direct current is being carried on continually. Dynamotors now under production in large quantities provide power for aircraft communication equipment, converting low-voltage d.c. from the ship's batteries to higher voltage power needed for radio operation.



Electronically sampling purified hydrogen gas for heat-treating steel in atmosphere furnaces.

The largest wound rotor motor in the world was designed and manufactured by Westinghouse to supply power for the full-scale wind tunnel of the U.S. Army Air Forces at Wright Field in Dayton, O. This motor makes possible wind-tunnel testing of scale-model planes under conditions actually encountered in flying at 400 m.p.h.

LIGHTING EQUIPMENT

In conjunction with the Civil Aeronautics Administration, advances have been made toward standardization of airport lighting and control equipment for the various classes of airports. Extensive use of seadrome lights will make night landing and take-off of seaplanes and clipper ships as safe on water as on any landing field. Through the adaptation of Westinghouse floodlights, generators, and control equipment for mounting on an Army truck, portable floodlighting apparatus has been made available for emergency lighting of Army airports and advanced landing fields.

Greatly increased production and greatly reduced costs in heat-treatment of steels used for aircraft engines and other airplane parts has been accomplished through installations of "Endogas" heat-treating furnaces. Precipitrons have been of material assistance in aircraft engine production by maintaining the air in the plant free from dust and other foreign particles. Portable and stationary airplane engines are used for testing aircraft radio and other accessories. Dynamometers are used for loading aircraft engines during "green" and "final" runs. Great quantities of energy that formerly were dissipated in friction and heat during production testing have been recovered and converted into useful work through the use of loading generators. Electronic control equipment developed by Westinghouse for resistance welding has added greatly to the acceptance and use of spot welding in place of and in addition to riveting in the aircraft industry.

With the added stimulus of the present emergency, more and more progress is being made in the aviation industry every day, and the increased need for new applications of electrical equipment give the electrical industry a vital role in the war effort and a real opportunity to "Keep 'em Flying."

Progress in Electrical Experimentation of Aircraft

W. N. GOODWIN, JR.*

THE TREMENDOUS GROWTH in aircraft instrumentation shows the vital role instruments play in every function of aircraft flight operation. Modern aviation as we know it today would not be possible without these extra "senses" that project the eyes, ears, and touch of the airman, giving him immediate knowledge of every factor that influences the performance of the plane.

Many features in the operation of planes are purely electrical, such as battery-charging currents, voltages, antenna current, which require of necessity electrical instruments. In the case of nonelectrical quantities, such as engine temperatures, engine speed and many others, the electrical method offers the most flexible means of relaying these indications from vital engine or other remote parts to the instrument panel. No system yet devised works so well over the long distances from part to panel or is so light, reliable, sensitive, and easily installed and maintained as the electrical system. There are few functions indicated on the instrument panel that cannot best be transmitted by electrical means.

Because of the experience Weston Electrical Instrument Corporation had gained in making electrical instruments for the marine and other fields, it was a natural transition to apply this knowledge to the design of suitable, lightweight electrical aircraft instruments. So successful was this venture that today there are few approved aircraft instruments on the instrument panel which cannot be wholly or partly made by Weston.

The manufacturing functions of Weston Electrical Instrument Corporation fall naturally into two groups: one, the building of the entire electrical system—power unit and indicator; two, the building of indicators for electrical systems manufactured by other companies, in which accessories outside the Weston line are required.

In the first group, the outstanding Weston developments include: voltmeters, ammeters, radio frequency ammeters, the electric tachometer, the cylinder temperature indicator, and the oil, air, and coolant indicators.

W. N. Goodwin, Jr.

When the aircraft manufacturers began equipping their planes with tachometers, centrifugal types were used, but it quickly became apparent that purely mechanical devices would not satisfactorily meet the requirements. As Weston was successfully building electric tachometers for use in industry and in the marine field, redesign of their instrument for application in aircraft proved a satisfying answer to the aircraft problem. This light, reliable electrical tachometer soon became "Standard" equipment for aircraft use and has since proved its dependability in this service.

Weston, dual cylinder, temperature thermometer.

Once Weston had entered the aircraft instrument field, intensive research work was applied to development of other types of electrical aircraft measuring devices. Out of this work grew thermocouple instruments for measuring cylinder temperatures. Continuing research produced instruments equipped with automatic cold-end compensation which assures accurate indication at all times regardless of variations in cockpit temperatures. So important are these engine-temperature instruments that there is hardly an airplane that does not carry one or several thermoelectric cylinder thermometers.

Along with this development, Weston designed a multiposition selector switch to which a number of thermocouples, mounted in different parts of the engines or in several engines, can be connected, so that temperatures in any number of localities can be measured quickly, one by one. Thus it has become possible to make instrumentation even more complete without exceeding the practical limits of panel board space.

Other complete units designed and built by Weston Electrical Instrument Corporation are those that indicate oil, air, and coolant temperatures. Employing either the Wheatstone Bridge or the ratio meter principle, these systems obtain their accuracy from the versatile resistance bulb—a sensitive device that responds to the slightest variations in temperature. With these instruments the men in control of the ship can know at each moment whether or not all is well with the vital parts wherever temperatures of gases or liquids are a measure of safety and comfort of flight.

In the second group of instruments, in which Weston supplies the indicators only, can be listed: air-fuel mixture indicators, fuel flowmeters, radio-compass indicators, blind landing indicators, and others.

Today, Weston's large research staff is constantly improving old or creating new electrical instruments for all types of aircraft in civilian or combat service. Facilities and experience built up ver long years of service in this specialized field are being used to advantage in America's struggle for aircraft superiority.

* Vice-President in charge of Engineering and Research, Weston Electrical Instrument Corporation.

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"IT'S STRONG—And you can bet that strength pays off in safety and longer fighting service."

"IT'S SIMPLIFIED—Unit-construction puts automatic pitch control, plus the power for pitch changes, right in the compact propeller assembly itself."

Many a pilot on many a front could tell a better story of the Aeroprop than we can.

They've pulled the trigger on the deadly gun that pokes its barrel through the Aeroprop's hollow hub.

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They know what it means to fly behind a propeller that is always "on speed," a propeller that responds almost instantly to every flight maneuver—climbing, cruising, diving, *fighting!*

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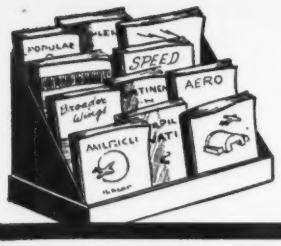
"Everything but talk!" The Aeroprop will never need to talk where ACTION speaks louder than words—where there are pilots who have flown with it, fought with it, and conquered with it.

AEROPROP

AEROPRODUCTS DIVISION **GENERAL MOTORS** CORPORATION

GM ARMS FOR VICTORY



Periodicals

Accessories

The S.U. Carburettor. F. C. Sheffield. This constitutes the first of two articles on a carburetor of British manufacture.

As a prelude to coverage of production methods, design features of this twin-choke, up-draft automatic carburetor are taken up. It has two main jets and two bellows for operating the needle valves, one bellows controlling the mixture in relation to manifold pressure and the other compensating for altitude effects. There is a pressure balance system between the float chamber and air intake, also a slow-running system with the usual diffuser and supplementary jets. An acceleration pump is provided.

Commenting on the general design, the writer discusses in detail jet diffusers, slow-running mechanism, pressure balance and mixture control. Inspection operations that include a final flow testing of the complete carburetor with paraffin are described. Production operations covered in this article include the machining of body castings, venturies and throttle discs. Illustrations show the principles of design and manufacturing methods. *Aircraft Production*, September, 1942, pages 537–543, 24 illus.

A New Driving Unit. An article describing the Rotol universal gear box, a driving unit for ancillary equipment, designed to free the engine of a number of projections and thus to facilitate maintenance and installation. It is driven from the engine by a shaft and flexible coupling and may be mounted either in front of or behind the fireproof bulkhead. This unit may carry as many as seven pumps of various kinds and two electric generators. *Aircraft Production*, September, 1942, page 576, 1 illus.

Aerodynamics

Vector Methods of Flutter Analysis. William M. Bleakney and J. Douglas Hamm. The application of vector notation to generalized flutter equations is described, and the advantages of graphic stability solutions are pointed out. The expressions for three-dimensional aerodynamic and mechanical coefficients are given. The use of stability curves in the presentation of data and the interpretation of these curves in terms of flutter characteristics are explained.

For solving the determinantal equation analytically, a convenient method of successive reduction in order is presented. In graphic solutions certain circle relationships have been found useful; when applied to determinantal elements, these relationships form the basis of solutions developed in two and three degrees of freedom.

The analysis of a symmetric flutter mode of a twin-fin tail is outlined to illustrate the methods of solution described. Actual examples of the evaluation of parameters are given and a circle diagram is applied to the solution of the stability equation. The circle diagram and a two-degree-of-freedom M-curve are used to determine the effects upon flutter characteristics of variations in parameters.

The simplifying assumptions as applied to different problems vary widely. Likewise, variations in the detailed graphic operations are used, depending upon the nature of the data and the information desired. *Journal of the Aeronautical Sciences*, October, 1942, pages 439–451, 8 illus.

A Simplified Two-Dimensional Theory of Thin Airfoils. J. J. Stewart. In the existing solutions of the thin airfoil problem, the determination of the steady state lift and moment of an airfoil of small camber and thickness, as given by Birnbaum, von Kármán, C. B. Millikan and others, the velocity potential for the flow is determined and the lift distribution and the integrated lift and moment are found from this result. It appears that a somewhat simpler solution of this problem can be obtained by working directly with the velocity components rather than with the velocity potential. This same method can also be used to advantage in many three-dimensional wing problems. An im-

INDEX

Accessories 161
Aerodynamics 161
Air Cargo 163
Air Power 163
Air Safety 165
Air Transport 165
Aircraft Spotting 167
Airplane Descriptions 167
Airports 169
Armament 171
Avigation 171

Bearings 171
Business and Finance 171

Camouflage 171
Civil Air Defense 173
Civil Aviation 173

Design 173

Engines 175

Flight Technique 175
Flight Testing 175

Gliding and Soaring 175

History 176

Inspection 176
Instruments 176

Jet Propulsion 176

Landing Gear 176
Lighter-Than-Air 176

Maintenance 177
Management 177
Manufacturing Equipment 177
Materials 177
Medicine 179
Metallurgy 179
Meteorology 180
Military Aviation 180
Model Airplanes 181

Naval Aviation 181

Paint 181
Parachutes 181
Personalities 181
Personnel 182
Photography 182
Plastics and Plywood 182
Production 183
Propellers 186

Radio 187
Research 187

Stress Analysis 187

Testing 189
Testing Equipment 189
Tools and Equipment 189
Training 189

Warfare 192
Welding 193

AN *old* member of the aeronautical industry becomes a *new* member of the Institute.

It is not a strange face among aircraft circles and its influence has not been lightly felt in the advance of aeronautics. But for its intakes, manifolds, oil lines, ignition shields and exhaust collectors, present weight per horsepower would not have been attained; nor present interchangeability realized.

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portant feature of this method is that the inverse problem, the determination of an airfoil shape that will produce a given lift distribution, can be solved just as easily as the direct problem.

The paper covers investigations of both the direct and the inverse problems. Calculations are presented for the total lift and pitching moment, followed by solutions for the flat plate airfoil and an airfoil having zero thickness and a small camber. The effect of thickness is analyzed and results of the analysis are applied to several examples. *Journal of the Aeronautical Sciences*, October, 1942, pages 452–456, 5 illus.

A Simple Method of Applying the Compressibility Correction in the Determination of True Air Speed. Wm. C. Schoolfield. By reviewing the complete impact pressure equation, which describes the pressure exerted by an air stream upon coming to rest, it is shown that the approximating assumption that is involved in the customary method of determining the true air speed of an airplane at altitude is no longer satisfactory for high-speed airplanes. The compressibility error that is a result of this assumption is isolated, and a method is described whereby the necessary correction may be applied by constructing additional altitude curves of indicated air speed ($V\sqrt{\sigma}$) on the conventional air-speed indicator calibration chart. The true air speed at any altitude is then determined by the usual method—from the known value of indicated air speed and atmospheric pressure and temperature. The error that results if the compressibility correction is not applied is shown to be +11 m.p.h. for a 400-m.p.h. airplane at 25,000 ft. altitude. The method here presented for applying the compressibility correction is less cumbersome than other suggested methods and has the additional advantage of retaining the use of the customary air-speed indicator calibration chart. Finally, the possible effect of compressibility on the position error of a pitot-static head installation is briefly analyzed and discussed, and the difficulties encountered in determining true atmospheric pressure and temperature in high-speed flight are mentioned. *Journal of the Aeronautical Sciences*, October, 1942, pages 457–464, 2 illus.

Air Cargo

The Hard Facts of Air Cargo. Reviewing the questions involved in proposals to construct a huge fleet of cargo airplanes, the writer holds that the matter is not one of making a choice between ships and airplanes, but of deciding the proportion of the total ton-milage to be moved by air and by water. Many of the problems involved in transporting materials and men to all parts of the world are discussed, one of the most important being the supply of raw materials from which to construct the needed aircraft without robbing other essential programs. Substitute materials are studied and it is suggested that the talents of Henry J. Kaiser could be employed in providing such raw materials. Statistics are quoted to show the magnitude of the task of transportation, not the least of which is the supply of fuel. Estimates are made on the fuel required for moving war goods by air compared with water and land routes, the point being made that it would require 35 tons of gasoline to move 5 tons of freight to Chungking by air and return the plane to the United States. It is predicted that improved airplanes will gradually bring about a better ratio of pay load to fuel consumption but that is not in immediate prospect. The advantages of air carriers are summarized, and caution is advised against exaggerated claims that cannot be realized under present conditions. *Fortune*, October, 1942, pages 84, 85.

Air Express Celebrates 15th Anniversary. Eric Bramley. In connection with the fifteenth anniversary of the establishment of regularly scheduled air express service, the history of that branch of aviation is traced and the significant periods are noted. Figures are tabulated showing the growth of air express shipments from 5,160 units in the September to December period of 1927 to 1,306,629 in the year 1941. Total weights, percentages and rates in 1941 are compared with 1940 and previous years, and statistics are presented on the operations of individual carriers. *American Aviation*, September 15, 1942, pages 28, 40, 2 illus.; "Remarkable Growth of Air Express Evident on Celebration of Fifteenth Birthday," *Commercial Aviation*, September, 1942, page 60, 3 illus.

Air Power

Sweden's Air Power. V. L. Gruberg. This analysis of Sweden's growing air strength considers the nation's industrial resources, facilities for the production of aircraft and engines, and the steps being taken for the expansion and modernization of the air force. It also deals with the organization of the air force as well as the marshaling of Swedish industry to furnish the necessary equipment. While it is conceded that the results of that country's noteworthy efforts cannot compare with the air power of belligerent nations, the opinion is expressed that growing defensive strength enables the government to withstand better and to deal more firmly with the demands of the Nazis. *Flight*, August 27, 1942, pages 234–237, 5 illus.

I Have Flown with the Japs. Lawrence Impey. Analyzing the strength, personnel, spirit and equipment of the Nipponese air forces, the writer leads up to the conclusion that, though they have certain factors in their favor, the Japanese fliers are inferior to the American and British. He traces Japanese air expansion from 1932, pointing out that the sudden emergence of their Navy Zero fighters and Mitsubishi navy bombers after the comparatively inadequate planes they were using over Chinese territory supports the theory that they were building up an air force for a major war. He marks the period when the air command passed from the control of the army to that of the navy as one of progress because of his belief that the Japanese navy is constituted of a smarter and more intelligent body of men than the army. Superiority of numbers is largely credited for their air supremacy in Malaya. The article also notes characteristics of Japanese airplanes as compared with several United Nations types. *Flying*, October, 1942, pages 41, 42, 91, 92, 3 illus.

Air War Needs in the Far East. Peter Masefield. Lack of adequate air strength is assigned as the chief reason for the losses suffered by the United Nations in the Pacific. Prospects are explored for counter measures in the future, the necessity for strong defenses for the airdromes of the Allies being accented. Methods of attack are analyzed, along with the means that should be employed for meeting such attacks. It is stated that the fighter plane is the foundation of air power. *Indian Aviation*, May, 1942, pages 127, 128, 1 illus.

Air Power Comes of Age. Part II. Major Nathaniel F. Silsbee. A discussion of air power which designates its function as threefold: to lend air support to and cooperate with ground and sea forces; to wage offensive war by strategic bombing; and to occupy territory by the rapid transportation of troops, equipment and supplies. With reference to the second point, reasons are given for the failure of the Luftwaffe in the Battle of Britain, and the strategic purposes and possibilities of the "aerial second front" over Germany are considered. The key men responsible for carrying out the United States' part in this aspect of air power are named.

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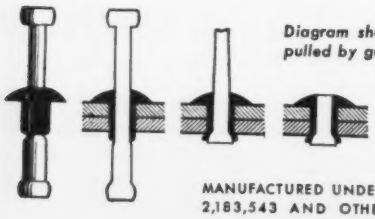

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in Norway, Crete, Africa, and China. The size and scope of United States Air Transport operations are indicated, and mention is made of several airplane types being devoted to this purpose. *Airlanes*, September, 1942, pages 6, 7, 16, 17, 1 illus.

Why French Aviation Failed. Maria de Blasio. In an interview with the writer, the former director of the French government's Arsenal d'Aeronautique gives reasons for the inadequacy of the French air force in combating Germany. He places the blame upon military inertia with regard to mass production, lack of money and time, and long delay in the obtaining of tools and raw materials. Among the things he comments upon is the loss of time in getting started on the building of a large air force, the refusal of the banks to make loans to the aircraft industry, and the failure to exploit the technical skill of French airplane designers. The engine industry was a particular drawback, according to this article, and mention is made of the neglect to promote parachute troops. *Flying*, October, 1942, pages 47, 48, 94, 97, 3 illus.

Air Safety

Safety in Reverse. The Safety Bureau of the Civil Aeronautics Administration shows that three times as many serious accidents occur in simulated forced landings than in actual ones. The study presents reasons for this and suggests two rules to be followed for the prevention of accients: (1) Know that the field chosen for simulated forced landings is adequate in all details to complete a landing safely in case of emergency; (2) discontinue the descent at a reasonable altitude above surrounding obstructions, not less than 200 ft., to permit free maneuvering in case an emergency necessitates an actual landing. Four tables of various data on simulated forced landing accidents supplement the article. *Southern Flight*, September, 1942, pages 20–22.

Air Transport

Burden Report Reveals Demand for More Air Service in S.A. Robert H. Wood. Highlights of the report of William A. M. Burden on South and Central American air-line operations since 1920, prepared for the Rockefeller Committee, are presented. In a study of the background for postwar air-line growth, the report shows that there is a greater need for air transportation in Latin America than there is in the United States. Commercial transactions between South America and other countries are discussed. The extent and volume of operations on the Latin American air-line network are compared with the United States domestic system. The proportion of revenues from commercial sources already being obtained by local South American air lines is stated to be large. Opportunities for both cargo and passenger traffic were evident, it was found. *American Aviation*, October 1, 1942, pages 38, 2 illus.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

They Started Something. William Flynn. A discussion of Henry J. Kaiser's proposal to build 200-ton cargo planes. The highlights in Kaiser's career of doing the impossible through short cuts in production are related. A brief biography is also given of Kaiser's partner in his contemplated aircraft venture—Howard Hughes. Stating the facts without offering any opinion as to the success of the program, the writer shows that it has already had the effect of speeding up competitive cargo-plane builders. The heads of several airplane companies are quoted in defense of current production of cargo planes. *Air Facts*, October, 1942, pages 21–29, 2 illus.

Atlantic Flight. D. A. Brice. A Ferry Command pilot describes his journey transporting a Lockheed Hudson bomber from Canada to Great Britain. First installment in a series of articles, this covers the part of the trip from Montreal to Newfoundland. It relates operational experiences as well as personal reactions. *The Aeroplane*, August 28, 1942, pages 245, 246, 3 illus.; September 4, 1942, pages 286, 287, 3 illus.

How Much Passenger Traffic? Edgar A. Van Deusen. As the basis for a statistical estimate of the future growth of domestic air traffic, the growth characteristics of other forms of transportation are reviewed. This study is confined to passenger travel on common carrier air lines. Among the topics particularized are: the phenomenon of growth, economic production, population and railroad travel, and a basis for estimating. Nine graphs supplement the article. *Aviation*, October, 1942, pages 215, 217, 218, 282, 285, 9 illus.

Air Transport Auxiliary. Activities, duties and accomplishments of the British Air Transport auxiliary are reviewed. A brief explanation is given of its methods of training personnel and maintaining its aircraft. Among the problems is the necessity for the unit to understand thoroughly the many types of airplanes and equipment it handles, a situation in which it differs from the Royal Air Force squadrons which generally deal with a single type of aircraft. *The Royal Air Force Quarterly*, September, 1942, pages 271–273, 3 illus.

Air Pick-up Goes to War. Jennings Randolph. A demonstration of the usefulness and success of the air-mail pickup service leads to the indication that the Army Air Forces' nonstop glider pickup system stems directly from this innovation. The modern prototype of rural free delivery, the air pickup service extended the benefits of air transport to communities not on regular air-line routes by an ingenious method of collecting mail and cargo. The article explains how this was done; gives figures on the costs, amount of mail and cargo carried; and shows how the service has contributed to the war program. It then goes on to describe the procedure followed in the pickup of gliders at different points by towing planes. *Flying*, October, 1942, pages 26–28, 112, 4 illus.

The Congo Air Force. Although it might be thought that the events of the war had paralyzed the activity of the Belgian air force in the Congo, the writer shows that the contrary is the case. Despite losses of airplanes and pilots through internment in French colonies in North Africa, aviation has been revived through the efforts of colonial men. Planes have been obtained and the transportation of passengers, mail and merchandise is proceeding. Routes have been established between Stanleyville and Johannesburg and to Egypt, covering nearly all of Africa. Flights aggregating 230,000 km. before the war have now been expanded to 2,000,000 km. Despite natural difficulties and equipment that is old, service is being maintained on a satisfactory basis. *Belgium*, September, 1942, pages 366, 367, 2 illus.

Torpedoes Can't Fly. Present developments and the future of air transport are discussed. The writer believes air transport is the key to Allied victory. Discussing the activities of Henry J. Kaiser, attention is drawn to the fact that he now is preparing for the building of flying boats of the Martin Mars type. Accomplishments of the R.A.F. Ferry Command and the United States Air Transport command during the war and of commer-

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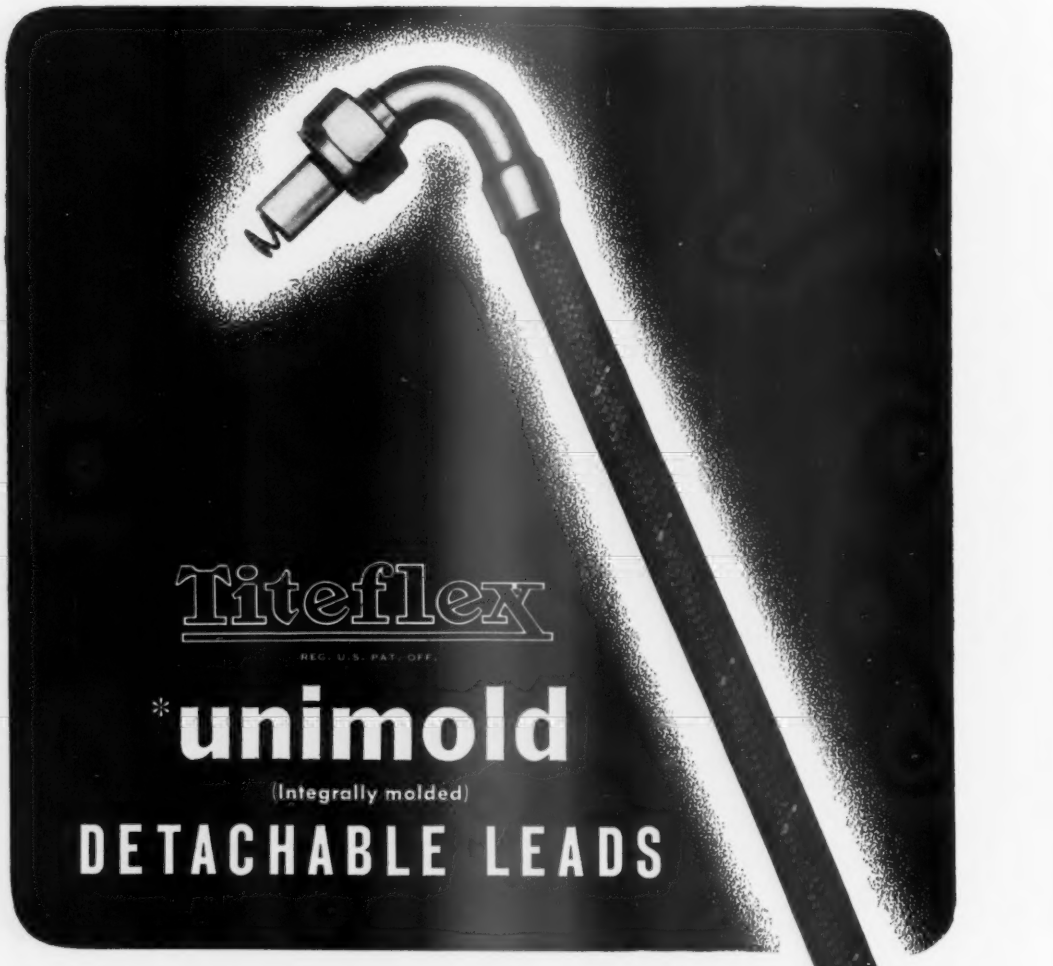

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cial air lines in peace years are cited as indications of the potentialities of air transport. Types of transport planes now in production are briefly described, and a comparison is drawn between these and present military aircraft. *Canadian Air Cadet*, September, 1942, pages 4, 5, 23, 24, 7 illus.

Air Mail Everywhere. Francis D. Bradbrooke. Details are submitted on the airgraph method whereby letters are photographed to a minute size on microfilm and the film is flown to its destination and on arrival is enlarged again at a cost to the sender of about 5 cents. In addition to a description of the process involved, indication is made of the resultant saving of time, weight and space. The routes along which airgraph service is now operating are outlined, and the possibilities of the system for postwar use are considered. *Flying*, October, 1942, pages 29, 98, 100, 2 illus.

Aircraft Spotting

Sketching and Recognition. Charles E. Sargeant. Sketching is advocated as an aid to aircraft recognition. In setting forth the elements of drawing, the writer shows that most objects to be sketched can be related to simple geometric figures. Instruction is developed along this line to the completion of an airplane silhouette. The principal steps are tabulated under 14 headings. *The Aeroplane Spotter*, September 10, 1942, pages 220, 221, 6 illus.

Airplane Descriptions

Dissection of the Dornier 217E. Design and construction features of the Dornier Do 217E are revealed. The article is based on a detailed report of the Department of Research and Development of the British Ministry of Aircraft Production. This monoplane is a high-wing, twin-engined type with twin fins and rudders. While it resembles earlier Dornier types, there are structural differences that are described. The fuselage is of unusually small cross section from near the leading edge of the wings to as far back as the tail. Electrical control features that include electrically operated brakes enable the pilot to carry out dive bombing practically automatically, it is stated. It has been found that this aircraft is designed not only for dive bombing but also for mine laying. Power for this aircraft is furnished by the B.M.W. 801A 14-cylinder, two-row, air-cooled radial engine, which appears to be supplanting the liquid-cooled Daimler Benz engine hitherto so much in favor with the enemy. The general design of the power plant is described. Drawings show various features of design. *Aeronautics*, September, 1942, pages 28–31, 9 illus.; "The Dornier Do 217E-1," *Aircraft Engineering*, August, 1942, pages 214–222, 23 illus.

Aircraft Types and Their Characteristics. Data are presented on the Focke-Wulf Condor, or FW 200, and the Consolidated Liberator II. Widely used for attacking Allied convoys in the Atlantic and for long-range over-sea reconnaissance and mine laying, the four-engined Condor is powered either by Bramo-Fafnir 323 air-cooled radial engines or B.M.W. 801 engines of 1,320 hp. With the latter its top speed is quoted at 279 m.p.h. at 18,100 ft. and its maximum range at slightly less than 2,300 miles. With the former its top speed is said to be 250 m.p.h. and its maximum range 2,430 miles.

The armament of the Liberator II is indicated as being a vast improvement over that of its predecessor, the Liberator I. This bomber incorporates certain features that are more usual to a flying boat than a landplane. Notable among these is the outwardly retracting undercarriage, which, attached beneath the inner engine nacelles, raises the wheels into recesses in the center section between the two nacelles on each wing. A nose wheel provides the tricycle undercarriage arrangement. Four Pratt & Whitney Twin-Wasp 14-cylinder radial engines of 1,200 hp. each provide a top speed of 335 m.p.h. at 16,000 ft., a cruising speed of 230 m.p.h., and a range at cruising speed of approximately 3,000 miles. The maximum loaded weight of the Liberator II is 41,000 lbs. and its bomb load is reported to be 8,000 lbs. *Flight*, August 27, 1942, pages 228a, 228b, 2 illus.

The Avro "Lancaster" Heavy Bomber. No. II. This is the second part of an article on the design and production of the Avro Lancaster heavy bomber. Information is offered on production methods as employed in one of the many factories devoted to the building of this aircraft. In the opening paragraphs reference is made to work carried out in the preplanning department to which the drawings completed by the design department and drawing office pass. Here, planning and progress aspects of each manufacturing operation are studied and a schedule of parts is developed. In following paragraphs shop methods and machine tools are described. To facilitate work in the shops, the construction is broken down to three main portions. A breakdown diagram aids in the explanation of how this is done. The latter part of the article is devoted largely to final assembly methods. Illustrations show a spar milling machine, jigs for the erection of floor sections, a section of the wing near completion, and the front section of the fuselage. *The Engineer*, August 21, 1942, pages 157–159, 5 illus.; "Britain's New Heavy Bomber," *Aircraft Production*, September, 1942, page 565, 1 illus.; "The Avro Lancaster, Britain's Newest Heavy Bomber," M. W. Bourdon, *Automotive and Aviation Industries*, September 15, 1942, pages 18, 19, 3 illus.

Portrait of the P-47. In a review of the details available on the Republic P-47, it is compared with the leading fighter planes of the enemy, including the Focke-Wulf FW 190, the Mitsubishi 00 and the Sento KI 001. The belief is expressed that its performance is superior to that of the best opposing aircraft, it being indicated that its full capabilities have not been revealed and possibly have not yet been discovered. Brief consideration is given to the relative merits of liquid-cooled and air-cooled engines on the basis of drag and ability to withstand gunfire. Other topics covered are the development history of the model, reasons for certain design features and the equipment. *Air Tech*, October, 1942, pages 14, 15, 8 illus.

Unique Features Included in New Plywood Military Trainer for United States Army. Constructional details are given on the Ryan plastic-bonded Army trainer. Comments are made on the design, handling qualities, construction details and operational features. *Commercial Aviation*, September, 1942, pages 90, 92, 94, 9 illus.; "New Ryan PT-25," *Aviation*, October, 1942, pages 235, 285, 3 illus.

Aircraft Types and Their Characteristics. Descriptions are given of the Vultee Vengeance and the Republic Thunderbolt. The Vengeance is a two-seater mid-wing cantilever monoplane dive bomber of all-metal construction. Its bomb load, armament, and performance are not publishable, but it is powered by a Wright 14-cylinder double-row Cyclone GR-2600 air-cooled radial geared and supercharged engine of 1,600 hp. Dive brakes are fitted under the outer panels of the wings. A hydraulically operated undercarriage that retracts backward, a long "glass-house" cockpit cover, and a large,

angular fin and rudder set forward in relation to the tapered tail plane are recognizable features of the Vultee Vengeance.

Powered by the Pratt & Whitney 18-cylinder Twin-Wasp engine of 2,000 hp., the Republic Thunderbolt (P-47B) is called America's fastest and biggest fighter. It is credited with a top speed of more than 400 m.p.h. and a total weight in excess of 13,000 lbs. Known to be heavily armored, with bulletproof petrol tanks and a powerful battery of large and small caliber guns, the possibility is mentioned that it carries one or more cannon. *Flight*, September 3, 1942, pages 256a, 256b, 2 illus.

Fw. 190 and B.M.W. 801. Features of Germany s latest fighter, the FW 190 which is equipped with a 14-cylinder, double-row, air-cooled engine of the type 801D, are revealed. Information is furnished on the general specifications and armament of the plane. A notable feature of the FW 190 is shown to be the master control unit, which governs the engine auxiliaries and keeps an inexperienced pilot from damaging the engine by overboosting or similar errors. Special attention is accorded to the twin-row engine, which is built into a self-contained unit completely enclosed in a low-drag cowling of only 52 in. diameter. Both the bore and stroke of the cylinder is 6.15 in. Further, it is pointed out that the use of a short stroke with relation to the bore has reduced crank-throw dimensions and crankcase diameter. Fuel is injected directly into the cylinders. Features of the air-cooling system are discussed and the method of oil cooling is described. A constructional drawing discloses the general design of the power plant, including application of the supercharger. A table of performance figures reveals that the engine take-off horsepower is 1,580 at 2,700 r.p.m. There are also drawings of the fuel injector, fuel injection pump and crankpin assembly. It is stated that B.M.W. engine units also are used on the Dornier Do 217. *Aircraft Production*, September, 1942, pages 566, 567, 5 illus.

The Potez 161. A description is presented of the Potez 161 flying boat, which a French combine had nearly completed shortly before the German invasion. This all-metal monoplane is of the high-wing, strut-braced type fitted with retractable wing-tip floats. It is powered with six 1,000 hp. Hispano-Suiza engines, which propel the plane at a top speed of 220 m.p.h. With a commercial load of 2 tons, its range at a speed of 134 m.p.h. against a 37 m.p.h. head wind is over 3,700 miles. Various constructional details are discussed. *Automotive and Aviation Industries*, September 15, 1942, pages 48, 68.

Aircraft Types and Their Characteristics. Descriptions are given of a German fighter and a German bomber —the Messerschmitt Me 110 and the Dornier Do 217E. The maximum range of the Me 110 with auxiliary fuel tanks is in the region of 1,000 miles. Its heavy nose armament consists of four rifle-caliber machine guns and two 20-mm. cannon, but its rear protection is regarded as weak. Two Mercedes-Benz DB601N twelve-cylinder, inverted V liquid-cooled engines power this fighter, each developing 1,150 hp. at 15,000 ft. and yielding a top speed of 340 m.p.h. at 22,000 ft., a cruising speed of 285 m.p.h. at 16,500 ft., and a service ceiling of 32,000 ft.

The Do 217E may be used either as an ordinary bomber or as a dive bomber. For this purpose alternative tail pieces to the fuselage are provided one of which is a normal stern and the other embodies a novel form of dive brake. Fourteen-cylinder, two-row, air-cooled B.M.W. 801 radial engines are fitted to the Do 217E, each developing 1,500 hp. at 17,000 ft. The top speed of this bomber is reported to be 275 m.p.h.; its cruising speed 255 m.p.h. at 17,000 ft. It has a range of 1,010 miles and a service ceiling of

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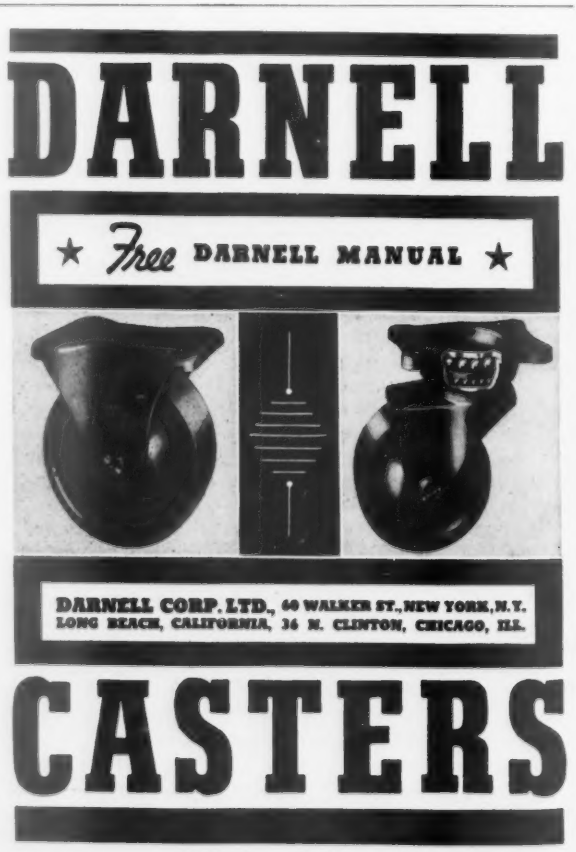
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22,500 ft. *Flight*, September 10, 1942, pages 281a, 281b, 2 illus.

Front Line Planes: A Gallery of American Plane Portraits. Brief descriptions are accompanied by full-page photographs of the following current American aircraft: North American Mustang (P-51); Bowlus Two-Place Glider; Republic Thunderbolt (P-47); Douglas Hemisphere Guardian (B-19); Curtiss Commando (C-46); Boeing Flying Fortress (B-17); North American Mitchell (B-25); and Curtiss Warhawk (P-40F). *Air Tech*, October, 1942, pages 26–34, 8 illus.

Pony With Wings. A brief description of the North American P-51 Mustang fighter. *Canadian Air Cadet*, September, 1942, page 7, 4 illus.

Lancaster Poses. Six photographs show an Avro Lancaster in flight. Features such as the layout, the field of fire of the gun turrets, the bomb capacity, and the maneuverability of this airplane are illustrated. *Flight*, September 10, 1942, pages 283–285, 6 illus.

Heavy Bombers. Modern heavy bombers of Great Britain and the United States are illustrated and described in this article. Reference is made to the recent landing at a Canadian airport of a single Lancaster, newest of the British heavy bombers and the first to be seen in North America. Comparisons are drawn between British and American heavy bombers. It is pointed out that British heavy bombers are flown at night and range is sacrificed to permit the carrying of heavy bomb loads. In U.S. types a heavy bomb load is sacrificed to obtain extreme range. They are designed to fly by day and carry out precision bombing. Bomb loads and range of the Lancaster, the Boeing Flying Fortress and the Short Stirling are compared. *Life*, September 28, 1942, pages 45, 46, 48, 6 illus.

In Defense of the P-40. Phillip Andrews. Fighting records of the Curtiss P-40 are cited in refutation of the adverse criticism of that model which, the writer states, comes mainly from the uninformed. In tests and in actual combat on 28 different fronts it is said that the P-40 has acquitted itself well, proving generally to be a match for the best of the enemy's specialized types. *Air Tech*, October, 1942, pages 40, 41, 4 illus.

A Stirling Job. F. D. Bradbrooke. A description of the Short Sterling I is presented together with data on its flying characteristics. Incorporating full dual control, this heavy bomber requires at least two men for essential duties. It is powered by four 1,600-hp. Bristol Hercules VI motors. In addition to listing specifications, dimensions, weights, loading, performance, etc., this article includes a detailed drawing of its equipment layout. *The Aeroplane*, September 11, 1942, pages 305–307, 6 illus.

The Mars. . . . Prima Donna Airplane of Today. Comments on the development of the Mars flying boat, built by The Glenn L. Martin Company, manufacturer of the China Clipper, are made. The prospect of larger aircraft of this type is discussed. *National Aeronautics*, September, 1942, page 16, 1 illus.

The Avro Lancaster. Full details are presented on the Avro Lancaster, characterized as the fastest of Britain's heavy four-engined bombers. Excellent controllability, freedom from defects, and ability to fly with one or two engines out of action are features stressed by the article. Topics covered in detail are: the center section of the bomber, the use of castings, undercarriage retraction, engine fairing, the internal layout, crew's stations, electrical installation, and cabin heating. Principal dimensions, power plant, armament, weight and performance figures are tabulated and drawings illustrate the parts of this airplane. Mention is also made of the men responsible for the design and construction of the Avro Lancaster. *Flight*, August 13, 1942, pages 174, 174a, 174b, 175–179, 17 illus.; *The Aeroplane*, August 14, 1942, pages 178–181, 6 illus.; *Commercial Aviation*, September, 1942, pages 24–28, 30, 32, 25 illus.; *Air Force Review*, September, 1942, pages 4, 5, 13, 3 illus.

Focke-Wulf Fw. 190. A description of the low-wing cantilever monoplane that is Germany's latest single-seater fighter. The article covers design features of the Focke-Wulf FW 190 as well as a study of its three flap positions, master control unit, bomb or extra fuel capacity, and speed capabilities. Data on the FW 190 is compared with those of other Axis fighters: the Me 109E and 109F, the Reggione Re 2000, the Macchi C 202 and the Macchi C 200. Air frame, equipment, cowling and accessibility are treated in the second installment. *Flight*, August 13, 1942, pages 182–185, 11 illus.; August 27, 1942, pages 224, 225, 5 illus.; *The Aeroplane*, August 14, 1942, pages 186, 187, 3 illus.; August 21, 1942, pages 216, 217, 10 illus.; August 28, 1942, pages 248, 249, 1 illus.; *Automotive and Aviation Industries*, September 15, 1942, pages 34, 35, 4 illus.; *Aviation*, October, 1942, pages 233, 306, 308, 4 illus.

Fernkampflugzeuge—die grossen "Viermotorigen" (Long Distance Bombers—the Big Four-Engined Ones). Ernst Wyss. The second and final installment of an article on the large, four-engined bombers of the United Nations and of the Axis powers gives descriptions and construction details, to the extent available, of the British Avro Lancaster, the Russian T.B.3, the German Focke-Wulf Kurier FW 200 and the Heinkel He 177, and the Italian Piaggio P 50. Specifications are tabulated for all but the first mentioned of these types. *Schweizer Aero-Revue Suisse*, May, 1942, pages 197–200, 4 illus.

Aircraft Types and Their Characteristics. Descriptive data and dimensions are given on the Avro Lancaster and Boeing Flying Fortress II. Capable of carrying a bomb load of approximately 8 tons, the Lancaster is normally powered by four Rolls-Royce Merlin XX twelve-cylinder, V-type, liquid-cooled engines. Its top speed is about 300 m.p.h. and maximum range approximately 3,000 miles, but these and the maximum bomb load cannot all be obtained simultaneously.

The Flying Fortress II, or B-17E, incorporates a number of improvements over its predecessor, the B-17D, or Flying Fortress I. It has considerably strengthened armament and greatly increased fin area. The power plant of this bomber consists of four Wright 14-cylinder, double-row Cyclone engines of 1,200 hp. fitted with exhaust-driven turbosuperchargers. Its top speed is said to be more than 300 m.p.h. and its maximum range approximately 3,500 miles. With an all-up weight of about 25 tons, its bomb load is reported to be about 3 tons. *Flight*, August 20, 1942, pages 202a, 202b, 2 illus.

Airports

The Bases of Air Power. Tom Ashley. An outline of the work being done by a United States Army organization of engineers specializing in Air Force work. Their duties, intended primarily for pioneer work on outlying airdromes where speed and utilization of existing facilities are essential, are listed as follows: (1) improvement or provision of advanced airdromes, together with all appurtenances such as runways, landing strips, shelter, airplane parking areas, internal routes of communication, water supply, light and other utilities; (2) improvement or provision of routes of communication to such airdromes; (3) camouflage of advanced airdromes and other Air Force installations; (4) assistance in the antimechanized defense of advanced airdromes by construction and defense of road blocks and by combat against raids delivered by ground forces; (5) assistance in the defense of advanced airdromes against air attack; and (6) maintenance and repair

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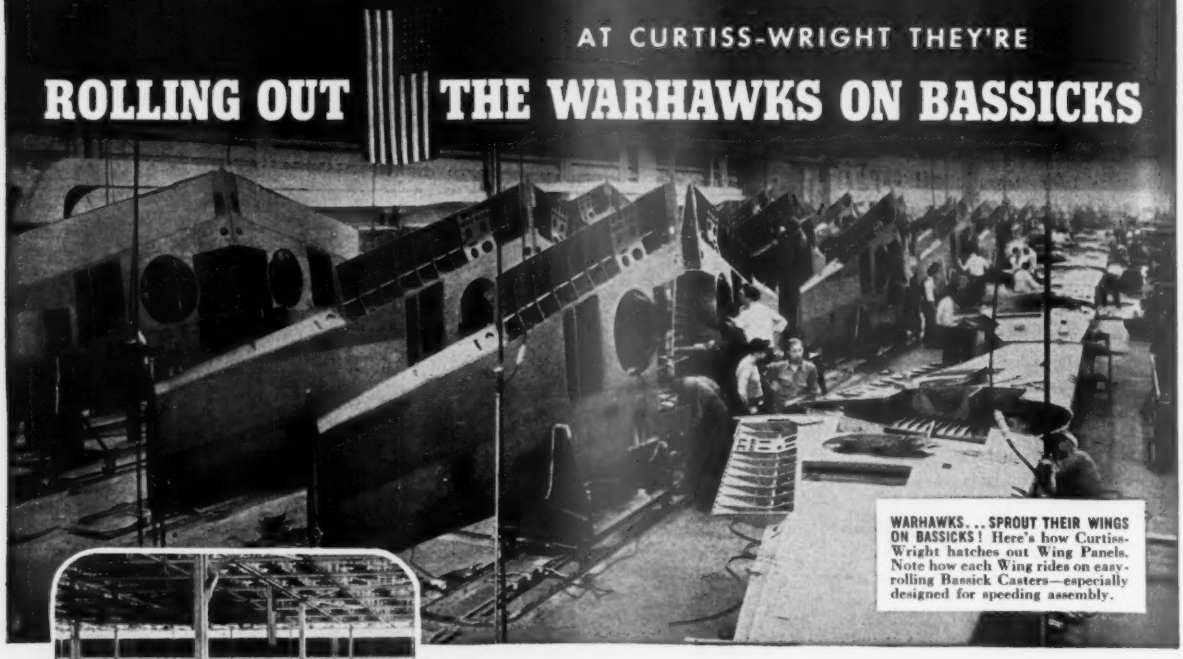

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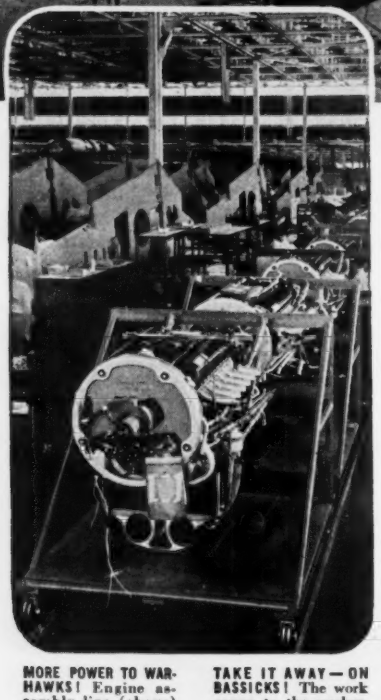

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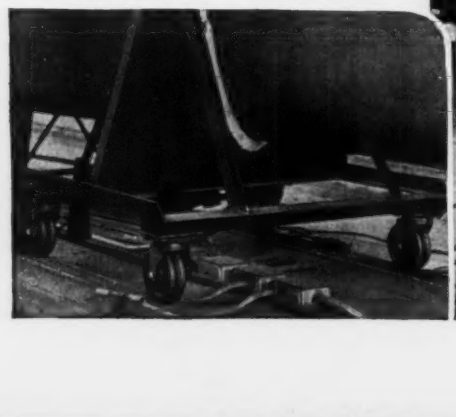

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of airdromes, especially after damage by enemy bombers.

Included are discussions of steel landing mats, camouflage, and operational airdromes . . . . all essential parts of the engineer's job. *Southern Flight*, September, 1942, pages 28–30, 6 illus.

Armament

Sound and Fury. Capt. Burr Leyson. Called the deadliest and most destructive weapon ever developed, the high-explosive bomb is studied and its applications to modern warfare are explained. Differences between such a bomb and an artillery shell are emphasized, especially the much greater range of the bomb. A mathematical formula is presented for determining the impact force of a bomb on striking its objective. The explosion of the bomb is analyzed as well as the effects upon buildings or other installations in the vicinity in which it falls. *Air Tech*, October, 1942, pages 8–11, 9 illus.

Avigation

Astral Aircraft Navigation. Prof. J. W. Melson. This fifth article of a series on aerial navigation deals largely with the use of almanacs in making calculations. A general formula is established, and problems are worked out with the aid of the almanac for calculating the local hour angle of various planets and stars. Navigation tables are discussed and examples are given for their use. *Canadian Aviation*, September, 1942, pages 61, 62, 64, 66, 68, 70, 78, 8 illus.

Buscando Nuestra Ruta en el Aire (Direction Finding in the Air). O. Cordero. The writer discusses various direction finding methods, such as the Mercator projection, gnomonic projection, conic or polyconic projection and the Lambert projection. For general rules of flight control he recommends: (1) careful plotting of the flight; (2) continuous control of the position of the airplane; (3) use of a good compass; (4) the practice of map reading until objects on the ground may be easily identified on a good map; (5) in case of lost direction, retracing the course over a part of the route until some landmark may be recognized. *Revista De La Fuerza Aerea*, April-May-June, 1942, pages 15–20.

Aerial Navigation. Practical and theoretic aspects of aerial navigation are outlined in nontechnical language. Sections cover the achievements of United States aircraft navigators, the instruments used to plot accurate courses, pilotage or navigation by landmarks, dead reckoning, and navigation by the stars. Illustrations cover the various phases of the subject. *Life*, September 28, 1942, pages 92, 93, 3 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Bearings

Surface Finish of Journals. R. W. Dayton, H. R. Nelson and L. H. Milligan. This paper deals with the effect of shaft finish on the seizure of plain bearings. Such seizure occurs when hydrodynamic lubrication is not maintained and is a serious problem in heavily loaded high-speed bearings, such as those in the master rod of radial aircraft engines. The final finish put on journal surfaces by the manufacturer is important to the behavior of the bearing in service, particularly during the critical "breaking-in" period. The writers describe tests conducted to study the surface finish of journals as affecting friction, wearing-in, and seizure of bearings. These tests were made on an Amsler machine under various conditions. *Mechanical Engineering*, October, 1942, pages 718–726, 8 illus.

Business and Finance

Profit Limitations By Treasury Directive. Selig Altschul. An interpretation is offered of the regulations issued by the Treasury Department, known as T.D. 5,000, which exert an important influence on the profits allowed to the aeronautical industry. These regulations apply to aircraft construction for the Army and Navy and have been extended to cover the relationships between the air lines and the Army Air Forces. The writer discusses the various definitions applied to the terms of contracts and gives consideration to the matter of renegotiation of contracts by which contract terms are altered from time to time by the Government bureaus concerned.

Costs and expenses are classified and a list is presented of items that are not allowed. Other matters included in the discussion are the relationship of the air lines to the War Department and the Air Transport Command and the functions of the price adjustment boards. The article tells how "cost plus" accounting is controlled and how it affects the earnings of aeronautical companies and their securities. *Aviation*, October, 1942, pages 100, 309.

Industry's Wartime Output Hits Total of $5\frac{1}{4}$ Billion Dollars. Statistics are presented on the dollar volume of production of the aircraft manufacturing industry during the three years of the present war. Percentages of increase are noted in the period from December 8, 1941, to August 31, 1942. Old-line aircraft companies are credited with important contributions to this achievement, while suppliers originally serving other industries are shown to be helping substantially. *American Aviation*, September 15, 1942, page 44, 1 illus.

Aviation's Dividend Prospects. Selig Altschul. The outlook for the stocks of companies in the aeronautical industry is explored. Accumulated earnings are compared with dividends paid and with market prices, a tabulation being included covering several of the large aircraft manufacturers. Price averages of 50 aeronautical stocks during the month of August, 1942, and at the end of August, 1941, are also tabulated, with separate figures for aircraft makers and transport companies. Financial and dividend histories of Aviation Corporation, Boeing, and United Aircraft are given in considerable detail, and comments are made on their tax position and prospects. Dividend records of numerous air lines are reviewed briefly. *Aviation*, October, 1942, pages 199, 200, 309.

Insurance for C.A.P. Norton Prentiss. An explanation of the insurance requirements of the Civil Air Patrol and the procedure used in meeting these requirements. Discussed in detail are the three types of insurance required: liability, hull, and accident. *Yankee Pilot*, August, 1942, pages 9, 10.

Camouflage

The How and Why of Camouflage. Harper Goff. An interpretation of the problems connected with camouflage, particularly that of war production plants. Requirements and methods, as well as the need for the "architecture of concealment" are studied. Worked out with a model, successive steps of camouflage are explained. The value of confusing the enemy rather than following more elaborate procedures of concealment or elimination is stressed. *Aviation*, October, 1942, pages 104, 105, 322, 325, 326, 8 illus.

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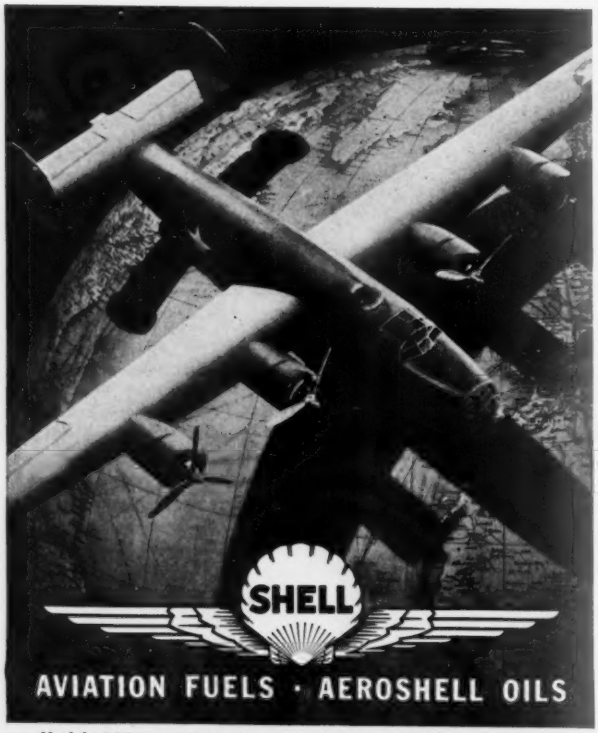

Model of Liberator B-24 shown courtesy Consolidated Aircraft Corp.

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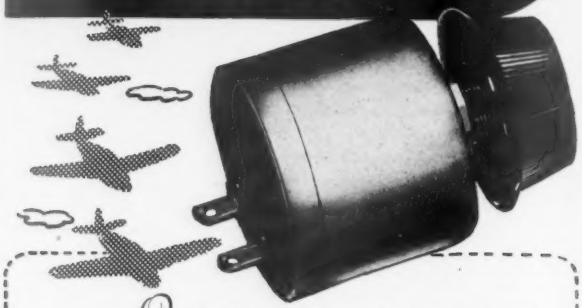

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Civil Air Defense

America's Anti-Aircraft Defense. Capt. Burr Leyson. Commenting on the increasing accuracy and effectiveness of antiaircraft fire in recent months by comparison with the best results obtained in the first World War and in the early periods of the present conflict, it is assumed that radio-location instruments are being used. The operation of known instruments that work on these principles is explained and the problems that must be solved for the successful application of such devices are set forth. Improved instruments based on these theories are credited with the successes recently registered by Britain's air defenses, and the prediction is made that widespread air bombardment is not likely to cause the havoc that it did in the past. *Air News*, October, 1942, pages 18–20, 42, 13 illus.

Lo Que Las Poblaciones Civiles Deben Saber (What the Public Should Know About Air Attacks). In order to give full information on air attacks to the general public the first installment of this article describes various types of bombing planes. It also describes the different types of bombs they carry, such as explosive bombs, chemical bombs, etc. Chemical bombs are classified as incendiary bombs, suffocating gas bombs, tear gas bombs and toxic gas bombs. There are also bombs for the purpose of spreading disease germs. Direct attack on civilian objectives by aircraft armed with cannons and machine guns and indirect attack by airborne troops are discussed. Antiaircraft defense is classified into active and passive defense. Among the mediums of active antiaircraft defense discussed are pursuit and fighter planes in the air and antiaircraft artillery, barrage ballons, searchlights, and listening and observation services on the ground. *Revista De La Fuerza Aerea*, April-May-June, 1942, pages 5–14.

Civil Aviation

Gullible's Travels. Leighton Collins. In an investigation on the conditions of cross-country flying for the civil pilot at present, the writer offers a series of comments on various airports that can be used as landing fields. His conclusions as to the feasibility of small-plane flying are that it is not seriously handicapped in the interior of the country and that the restrictions on other forms of transportation accent its importance as a potential means of travel. *Air Facts*, October, 1942, pages 42, 44–60, 7 illus.

El Tratado Chileno-Argentino de Navegacion Area (The Treaty Between Chile and Argentina on Air Navigation). E. Hamilton. The agreement on air navigation reached by the republics of Chile and Argentina is discussed. Based on existing international agreements that define the sovereignty of air space abôve the territory and jurisdictional waters of the country, provisions covering prohibited zones, registration of aircraft, etc., are presented in detail. Customs, regulations, coordination of meteorologic services and further treaty details are given. *Revista De La Fuerza Aerea*, April-May-June, 1942, pages 29–33.

Private Flyers to the Rescue. Russ Johnston. Warning of the possibilities of sabotage fires in west coast forest lands and the far-reaching results of such disasters, the writer urges that the C.A.P. be used for air patrolling of this area. He discusses the qualifications of C.A.P. members for such a job, also suggesting methods for the efficient carrying out of the plan. Although cognizance is taken of the fact that this patrol might complicate the problems of the West Coast Interceptor Command, the opinion is expressed that this constitutes but a minor drawback that could be worked out. *Flying*, October, 1942, pages 44–46, 4 illus.

Arbeitsbeschaffung und Zivilluftfahrt (Works Program and Civil Aviation). Preliminary details are set forth, as made public by the Swiss government, of a large-scale transportation and communication works program which will extend over a period of from five to ten years. For the extension of civil aviation the sum of 200,000,000 francs has been provided, to be used for the improvement of existing airports or the construction of new ones. A special study is made of the proposal to have a Swiss central airport which would be a direct connecting point in international air service. There seems to be no doubt that such service is to be resumed as soon as the war is over. *Schweizer Aero-Revue Suisse*, May, 1942, page 173.

Design

From the Ground Up. Sandy A. F. MacDonald. An elementary explanation of the construction of the various parts of an air frame. Among the components given special consideration are: the wing, tail unit assembly, undercarriage, shock absorbers, brakes, engine mountings, fire wall, tank installations, and controls. *Air Force Review*, September, 1942, pages 16, 17, 22, 23, 27, 12 illus.

Unobtrusive Cleverness. A study of the aerodynamic design features of the North American Mustang being used as an Army cooperation plane by the Royal Air Force. Specially noted are the wing thickness and the tail arrangement. Dimensions and specifications are included. *Flight*, August 20, 1942, pages 209–211, 9 illus.; "Fighter—Reconnaissance for the Army," *The Aeroplane*, August 21, 1942, pages 219, 220, 5 illus.

The Truth About Our Fighter Planes and **The Truth About Our Bombers.** Disproving alleged inferiorities of United States airplanes, an analysis is presented of American types as compared with those of other major air forces. For the fighter planes the conclusion drawn is that, while on some points other nations' models excel this nation's, in most instances this is not true and that on the whole the adaptability and versatility of American fighters give them the advantage in aerial combat. Detailed performance characteristics and other qualities of the following fighters are offered for comparison: American—Curtiss P-40 series, Bell Airacobra, North American Mustang, Republic Thunderbolt, Lockheed Lightning; British—Spitfire and Hurricane; German—Focke-Wulf FW 190, Messerschmitt Me 109 series, Heinkel He 113; Japanese—Zero.

From an examination of the characteristics and performance records of United States bombers, the conclusion drawn is that the heavy bombers compare favorably with the excellent British units, while the medium and light bombers are without equal. Emphasis is placed upon the importance of the latter factor in this war of multiple fronts. Long-range, four-engined bombers considered on points of speed, range, armor, and armament or bomb capacity are: American—Flying Fortress and Consolidated Liberator; British—Handley Page Halifax, Short Stirling, Avro Lancaster. In the medium bomber class the Lockheed Hudson, North American Mitchell, and Martin B-26 are discussed, while in the light attack-bomber division, the Douglas A-20 receives mention. *Aviation*, October, 1942, pages 93–95, 334–336B, 6 illus.; pages 96, 97, 328, 329, 4 illus.

Flying Work Horses Must Shed Weight. E. J. Foley. Functional design is emphasized as an important factor from the standpoint of the ultimate utility of a transport airplane.

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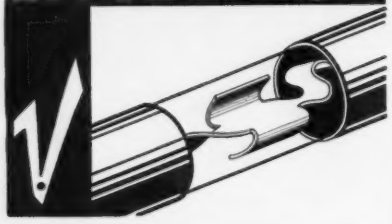

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It is shown that a saving in weight in the original design may not prove to be worth while if it results in high costs for maintenance and in the loss of service time for the airplane while repairs are made. *American Aviation*, September 15, 1942, page 26.

Stressed-Skin Pioneering. Oswald Short. Great Britain's claims in the field of stressed-skin development are presented. In refutation of the belief that this type of aircraft construction originated in the United States, the writer states that he was the originator of stressed-skin all-metal construction in 1919 and that the Short "Silver Streak" was the first product of this change in design. He tells how it was first exhibited, when the idea was adopted and developed, and how it was introduced in the United States. *Flight*, September 3, 1942, pages 250–252, 9 illus.

Slots and Flaps. L. Leavy. An article on the subject of high-lift devices for aircraft, which are classified into two main groups—slots and flaps. That wing loads have been increasing since 1925 is shown by a graph of the trend in wing loading on single-seater fighters. With the general adoption of monoplane fighters about 1936, wing loads went up rapidly. It is explained that this increase was made possible by the high-lift device. Requirements of high-lift devices are discussed and advantages and limitations of some of the better known types are summarized. *Aeronautics*, September, 1942, pages 50–55, 13 illus.

Estimating Take-Off Weight—II. W. Nicholls. The second article on the subject of estimating the weight of an airplane at take-off is devoted to the heavy bomber, whereas the previous article covered the single-seater fighter type. It is said that the problem is more difficult in the case of the bomber, since the earlier formula could not apply because of the additional loads to be carried. Two identical airplanes of the same gross weight might have bomb loads varying as much as 50 per cent. Hence, four known loads should be taken into consideration in estimating the basic load, which is found to vary between 47 per cent and 51 per cent of the take-off weight or an average of 49.1 per cent. Representative values of percentages of the basic load are tabulated, and curves are plotted from which a selection can be made for the calculation of the take-off weight. The application of this method is set forth in an example, it being stated that results have been verified to show a degree of accuracy within the range of minus 1.8 per cent and plus 1.6 per cent. Other data for bombers include weights of wings, fuel tanks, oil tanks, wing loading and power loading. *Flight*, August 20, 1942, pages 207, 208, 1 illus.

A U.S. Army Transport. A critical report on the operational qualities of the CW-20, civil prototype of the C-46 Curtiss Commando, which has been doing transport duty with the British Overseas Airways Corporation. While the flying qualities of the CW-20 are judged to be excellent, the opinion is offered that it incorporates two defects in its ground action. One criticism is that because its wheel loading is too high there is a tendency for the wheels to sink into the supporting surface; the other, that the airplane has a tendency to turn head-on to the wind.

The article also presents various data on the CW-20. Tabulations are given on weights, performance and engine particulars. *The Aeroplane* August 28, 1942, pages 256, 257, 1 illus.

Dornier Diving Brakes. A group of air pictures demonstrate the Dornier's umbrella brakes in action. Views of fully opened and fully closed positions are included. When the brake is opened to its full extent, the aircraft is capable of diving at a speed of 430 to 490 m.p.h. *Flight*, August 20, 1942, page 205, 6 illus.; "The Dangling Dornier," *The Aero-*

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plane, August 21, 1942, page 218, 6 illus.

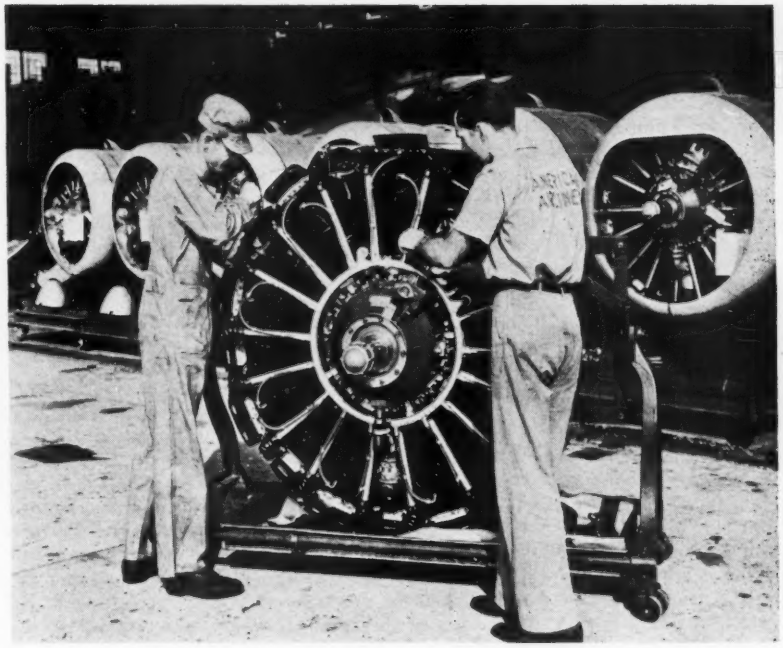
Engines

"Ready-to-Fly" Power Units. Three photographs illustrate some brief details on the standardized power plants manufactured by Rolls-Royce Ltd. Complete to radiators, cowlings, exhausts and air intakes, these units are ready for immediate installation. The airplane is designed to accommodate them, thus saving the time and energy needed to adapt a new or existing engine to meet the requirements of the plane. The Merlin XX, installed in the Avro Lancaster and the Beaufighter II, is an example of this type of standardized Rolls-Royce engine. *The Aeroplane*, September 4, 1942, page 280, 3 illus.

Keep 'Em Cooling. Everard M. Lester. In nontechnical language the theory of operation of the internal-combustion engine is explained and methods of cooling are discussed. The cooling of the Ranger in-line, air-cooled engine is described, particularly the system of pressure flow of air around the cylinders. *Air Tech*, October, 1942, pages 50, 52, 53, 6 illus.

The B.M.W. 801 Aero-Engine. An article is presented on Germany's B.M.W. 801 14-cylinder, two-row, radial air-cooled engine. The information is from *Flugsport*, May, 1942. In the opening paragraphs a general description of this fuel injection engine is furnished. It is supplied either as a complete power unit with mounting ring cowling or as a naked engine including the airscrew pitch-changing gear. It is explained that the engine body consists of six parts: crankcase, reduction gear casing, blower casing, air-intake casing, and oil pump. Materials used for these units are named and details of design are touched on. Design features of the crankshaft, connecting rod assemblies and cylinders are discussed. The cylinder consists of a finned steel liner with a rigidly connected shrunk-on light alloy cylinder head. The valves are inverted and situated at an angle to each other. The supercharger is a centrifugal blower with a two-speed gear. It is operated through a multiple disc clutch. Details of engine cooling and lubrication are covered. Photographs and constructional drawings show design features. *Aircraft Engineering*, August, 1942, pages 223–227, 9 illus.; *Flight*, August 13, 1942, pages 169–173, 11 illus.; August 20, 1942, pages 201, 202, 4 illus.

Specifications on the Rolls-Royce Merlin XX Engine. Details of the Rolls-Royce Merlin XX engine are reprinted as released by the British Ministry of Aircraft Production. *Commercial Aviation*, September, 1942, pages 72, 74, 78, 1 illus.



Installing the ignition harness on the Wright engine of one of the American Airlines' Flagship fleet. The ignition cable has an inner braid of Fiberglas fabric.

Flight Technique

What the Airplane *Wants* to Do. Wolfgang Langewiesche. A study is presented in nontechnical language of the airplane's stability under different conditions. Explanation is made of the plane's inherent trend toward stability and reasons are given why it will act otherwise. Functions of the tail are discussed, the horizontal stabilizer being called probably the least-understood part of the airplane. Influence of pilot control, relative wind and other natural conditions, and design are all considered. *Air Facts*, October, 1942, pages 61–76, 4 illus.

"Annie" the Avro Anson. A pilot tells how to operate the Avro Anson trainer. It is explained that handling the Avro Anson is no more difficult than flying lighter single-engined aircraft, but the pilot must familiarize himself with the many instruments and controls found on this airplane. *Canadian Air Cadet*, September, 1942, pages 14, 15, 30, 1 illus.

Basic Theory of the Dive Bomber. Aeolus. Basic principles of dive-bomber technique are outlined. It is explained that dive bombing consists in launching a bomb at a moment when the flight path of the aircraft coincides with the aiming line and approximates the subsequent bomb trajectory. The aim line, which is the same as the flight path, may not be directly at the target, since some allowance must be made for gravitational pull on the bomb. It is pointed out that dive brakes are not necessary if the airplane has a high drag but are essential equipment of the modern low-drag dive bomber. Features of the German Stuka are mentioned. The relative vulnerability to antiaircraft fire of the dive bomber and the level flight bomber is discussed. Diagrams clarify the explanations. *Aeronautics*, September, 1942, pages 36–38, 4 illus.

Flight Testing

Flying the Catalina. Pat Howard. The test pilot who flew the first Boeing PBY flying boat built in Canada tells of his impressions and describes the performance of this aircraft. *Canadian Aviation*, September, 1942, page 39, 114, 1 illus.

Gliding and Soaring

Hotspur Glider—R.A.F. Hot Foot for Hitler. William S. Friedman. Britain's extensive program for building gliders, training glider pilots, airborne troops and maintenance crews has been kept secret for some time but has now grown to such proportions that a part of the story is being revealed. The selection and basic training systems are described briefly. An intensive course in basic aerodynamics glider theory, meteorology and military tactics is followed by solo flying

of light planes, after which the students go directly to the eight-place Hotspur tactical glider. Practice is given in precision take-offs and landings and then proceeds to multiple-tow operation. After the student learns to cut loose and keep clear of the formation, he graduates and is sent to a tactical unit. It is predicted that for the immediate future sporadic glider raids will be made in occupied territory on the Continent. *Air News*, October, 1942, pages 26, 27, 5 illus.

Logistics and the Glider. J. Russell. The writer discusses the glider's part in military operations with special reference to the opening of a second front against Germany. It is explained that the purpose of the glider is to move troops quickly and efficiently to where they will do the most damage. Suggestions are made on how gliders could be employed in an overseas attack. An outline is given of how glider pilots are trained. This is followed by a description of various types of gliders and a discussion of future glider developments, particularly with regard to mobility. *Aeronautics*, September, 1942, pages 40–43, 10 illus.

Sparrow Flies High. Describing the first flight and the design features of the glider plane, Sparrow, built at the de Havilland Aircraft plant. *Canadian Air Cadet*, September, 1942, page 10, 5 illus.

History

The Aircraft Industry's Path to War. Cyril May. The writer traces the development of the British aircraft industry to the point of peak production. The full magnitude of the industrial achievement, which has been the mainspring of the growing power of the Royal Air Force, cannot be made plain until after the war, it is stated. The various phases of development are gone into in considerable detail. *Aeronautics*, September, 1942, pages 56–59.

Air Borne Mail. H. E. Radasch. The history of delivery of mail by air is reviewed, mention being made of pigeons, balloons, dirigibles, catapults, rockets and gliders. The earliest balloon delivery of mail mentioned is the ascent of J. P. Blanchard in 1784 in London, when he dropped postcards to friends. Other balloon flights are recalled, with information on the mail deliveries thus accomplished. The development of airplane mail service is traced from 1911. Glider mail flights and rocket deliveries of mail are also discussed. *Airpost Journal*, October, 1942, pages 15–17, 3 illus.

Flying, As It Was. Leon L. Watters. An eyewitness description of the first fatality in a powered airplane—the death of Lt. Thomas E. Selfridge after an exhibition flight with Orville Wright when the plane crashed. The accident took place at Fort Meyer, Va. on September 17, 1908. Details are given on the flight and its purpose, as well as reasons for its failure. *The Sportsman Pilot*, September 15, 1942, pages 22, 23, 48, 10 illus.

Inspection

"Glo-Crack." This article covers a process for detecting cracks in ferrous and nonferrous materials. This process has been developed by the Colloidal Research Laboratories Ltd., London. It depends on the fluorescence of certain materials when exposed to ultraviolet light. Details of the process, which involves the immersion of specimens to be examined in a bath of fluorescent material, are described. A washing operation removes all material except that which has become anchored in flaws or cracks. When the part is exposed to ultraviolet light from a suitable lamp, it is stated that cracks show up with startling vividness. How cracks are detected with this method is illustrated by photographs. *The Engineer*, September 4, 1942, page 201, 3 illus.

Internal Inspection. The writer outlines various means that have been devised for the internal inspection of wing structures. The problem of inspecting the interior of tubes is discussed. Information then is furnished on the optical system used in the Foster Introscope, an instrument especially designed for internal inspection work. Different types of this instrument are described. Diagrams show stages in the development of efficient equipment for internal inspection. *Aircraft Production*, September, 1942, pages 573–576, 10 illus.

Instruments

How High Is Up—Exactly? J. Clifton Carr. An explanation is presented in nontechnical language of the sensitive altimeter and the principles upon which it operates. It is recommended that major repairs be undertaken only by a competent service depot or the manufacturer, but certain adjustments can be made in the field, for which instructions are given. *Air Tech*, October, 1942, page 49, 1 illus.

It's Done with Mirrors. Lewis Tansky. Description of the photographic recorder used by Republic Aviation Corporation for the compilation of instrument data during flight tests. Details are given on the procedure and its accomplishments, as well as the actual components of the photographic equipment. *Flying*, October, 1942, pages 28, 93, 94, 4 illus.

Jet Propulsion

Jet Propulsion Developments. P. M. Heldt. A review of what has been accomplished in the development of jet propulsion as applied to aircraft is presented. Reference is made to an airplane equipped with the Campini system of jet propulsion which was reported to have been flown from Milan to Rome last winter. Principles of jet propulsion are outlined. It is pointed out that if, instead of letting gases under pressure act against a movable piston, they are allowed to act directly against the atmosphere behind the airplane a propulsion effect is obtained in a simpler way. The problem of practical jet propulsion is one of obtaining a heat-energy-to-propulsion-energy conversion efficiency comparable to conventional engine-propeller systems. The efficiency that must be reached with jet propulsion for performance equal to that of engine-propeller systems is estimated. In addition to a description of the Campini propulsion system, information is furnished on the Lysholm and Hahn propulsion units. Drawings clarify the text and photographs are shown of the Caproni-Campini jet propulsion plane. *Automotive and Aviation Industries*, September 15, 1942, pages 30–33, 6 illus.

Landing Gear

Theory of Aircraft Undercarriages in Relation to Absorption of Initial Landing Impact. P. B. Walker. This article deals with theoretic considerations of the undercarriage viewed only as a device for absorbing initial impact on landing. Sections cover the basic problems of shock absorption and energy, the vertical buffer or cantilever oleo, the energy of descent, and landing without energy absorption. The principle of the drag undercarriage, its limitations, the compound undercarriage, and the inverted compound undercarriage are discussed. *The Journal of the Royal Aeronautical Society*, August, 1942, pages 186–197, 8 illus.

Lighter-Than-Air

Blimps Return to the War. R. G. Picinich, Jr. A general discussion of airships which indicates the usefulness of rigid as well as nonrigid types in this war. It is stated that nothing has been developed since World War I to detract from the blimp's value in the field of reconnaissance, inner coastal

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patrol, submarine and mine defense, and convoy, since blimps can take off in low-ceiling weather inoperable to other aircraft, can fly slowly, and can hover over one spot.

As for rigid airships, it is claimed that their long cruising range can be applied to reconnaissance missions in the great expanses of the South Atlantic and the Pacific. Further claims for them are that they can be used as flying carriers to transport a number of small bombing planes to points near the place of attack as well as to carry parachute troops, munitions, and armament. Traveling at speeds not attainable by surface ships, they could also operate in areas impossible to other aircraft. *Aviation*, October, 1942, pages 207, 306, 3 illus.

Maintenance

Locating Ignition Trouble. H. N. Walker. Modern test methods are set forth for locating ignition troubles in aircraft engines. Although spark plugs should be considered, all troubles should not be arbitrarily charged to those devices, according to the writer. He also discusses cylinder pressure, temperature, spark-gap setting, ignition timing and other factors. It is suggested that the entire ignition system be considered, especially the cables and installation of the harness. The correction of faults and testing at the bench and in the field are explained. *Aviation*, October, 1942, pages 211, 300, 303, 304, 1 illus.

Motorized Ground Units Keep 'Em Flying. A brief description is given of the motorized mechanical equipment used for the support of Army aircraft. Tanks, trailers, jeeps and cranes play an important part in this service, it is explained. Standard Army vehicles are unsuitable for specific purposes. The types of special vehicles fall into five classes, which are outlined. *National Aeronautics*, September, 1942, page 34, 2 illus.

Mass Production to Change Maintenance. E. J. Foley. Consideration is given to aircraft maintenance as applied to mass commercial air-line traffic. It is emphasized that maintenance must keep pace with high-speed manufacturing effort and vigorous operating technique. Problems of maintenance and their possible solutions are discussed. The need for greater accessibility is stressed. The responsibility of the manufacturer in the movement toward more efficient maintenance is considered. In discussing the basic technique of maintenance, reference is made to two schools of thought—namely, periodic overhaul, which assumes the regular withdrawal from service of each operating aircraft; and continuous overhaul, which ordinarily is accomplished without any major disassembly during the life of the aircraft. Both methods are analyzed. *American Aviation*, October 1, 1942, pages 50, 51, 59, 1 illus.

Wind, Sand and Trouble. Capt. Charles Kennett. Difficulties that must be overcome in operating and maintaining aircraft under conditions prevailing in the desert are narrated. Damage caused by wind-blown sand must be guarded against every moment, as well as the effects of heat. The effects of sand on propeller blades, instruments, pitot tubes and other airplane parts are reviewed and the work of the maintenance crews under such conditions is explained. *Air Tech*, October, 1942, pages 12, 13, 3 illus.

Preventative Maintenance. This article relates how the program of C.P.T.P. maintenance supervisors was set up, how it functions, and how it has effected an increase of airplane flying hours and a decrease of accidents.

It is the work of C.P.T.P. maintenance supervisors to check every plane in their districts once a month. If, in their inspections, they find anything wrong with a plane, they show the mechanic the trouble, tell him what caused it, and how to correct it. A complete report of the difficulty is then written, forwarded to Washington through the regional office, copied into bulletins, and sent on to other maintenance supervisors throughout the country. With this continual flow of information to operators in the field maintenance methods are kept up to date and improved. *Flying*, October, 1942, pages 55, 87, 88, 2 illus.

Patching Plexiglas. Edmund Greene. Methods of repairing Plexiglas are said to fall into two general categories: those that can be used in the field and those that require a properly equipped shop. Instructions are given for temporary repairs and emergency patches and for permanent work to be performed in the shop. *Air Tech*, October, 1942, pages 22, 23, 12 illus.

To Keep 'Em Flying. An American Service Depot for the maintenance and repair of U.S. Army aircraft in Britain is described. This is one of a series of stations being set up in Britain by the United States Army Air Force Service Command under Major Gen. W. H. Frank. The precision and efficiency with which the work is being done win commendation from the British writer of the article. *Flight*, August 27, 1942, page 228, 1 illus.

Preservation. W. E. Koneczny. A consideration of the effects of certain atmospheric elements upon the maintenance of aircraft. Protection under conditions of heat, moisture, dust, cold and wind is studied. *Dixie Air News*, September, 1942, pages 11, 31.

Gas: Hot and Otherwise. H. Kristofferson. Based on the experiences of Pan American Airways in operating flying routes through unsettled areas, fundamental rules are presented for handling and storing airplane fuels and lubricants on war fronts and under primitive conditions. The principal rules are: (1) have proper equipment; (2) spread out fuel supplies to minimize risk of loss by bombing; (3) keep tanks cool; (4) guard against sparks; and (5) do not overfill tanks or cans but allow for expansion. New devices are mentioned which are intended to make easier the tasks of the crews of advanced airplane bases. *Air Tech*, October, 1942, page 48, 1 illus.

Management

Parts Makers' Dilemma. Jack Frost. The Executive Secretary of the Aircraft Parts Manufacturers Association discusses some of the major problems confronting this group. The questions of labor supply, wage stabilization, price regulation, equitable profits, and taxes are considered from the point of view of this association, which represents 140 companies engaged in various phases of aircraft parts processing. *Southern Flight*, September, 1942, pages 45–47, 1 illus.

Manufacturing Equipment

Pipe Bending. An article covering additional applications of the Blackburn precision process of pipe bending by special press methods. The bending of pipes of over $1^1/_2$ in. diameter is described. *Aircraft Production*, September, 1942, pages 535, 536, 3 illus.

A New Stretching Press. Details of a 150-ton stretching press, manufactured by the Hydraulic Press Manufacturing Company, are described. The machine is used for forming large sheet metal aircraft parts. *Aircraft Production*, September, 1942, pages 561, 562, 3 illus.

Materials

Nitriding an Aircraft Engine Part. Gerald E. Stedman. Using as an example a propeller shaft thrust bearing

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spacer for an aircraft engine, information is presented on the practices of nitriding steel and the associated operations of normalizing, hardening, tempering, machining and others. After detailing the dimensions of the spacer and the analysis of its raw material, the processes of forming and machining it are traced through six general operational sequences and their inspections, with many other incidental operations. How the nitriding furnace is loaded and the actual process of nitriding are explained, and the tests applied are listed. *Metals and Alloys*, September, 1942, pages 420–423, 4 illus.

Magnesium Alloys—Cast and Fabricated. A pictorial presentation shows some of the operations of casting, extruding and rolling which enter into the production of various alloys of magnesium. Comments are made on the properties imparted by alloying this metal and on the chief alloying elements found. Captions explain the operations depicted. *Metals and Alloys*, September, 1942, pages 429–436, 12 illus.

Medicine

Auditory Sensitivity Under Conditions of Anoxia: A Study of Speech Intelligibility. C. P. Seitz and G. M. Smith. The purpose of the present study is to inquire into the effect of oxygen deprivation on the ability to perceive speech sounds in the easily audible range of stimulus intensities. It is obvious in dealing with this problem that two major variables are involved: (1) anoxia and (2) pressure. Pressure affects not only the availability of oxygen for the organism but also the ear and communication system in a mechanical sense. This exploratory study is restricted to oxygen deprivation uncomplicated by pressure changes. Details are presented on the materials and methods used, the subjects studied, the procedure followed and the results obtained. *Journal of the Aeronautical Sciences*, October, 1942, pages 478–480, 1 illus.

Prone Fighters: You Can Take It Better Lying Down. Effects of acceleration and velocity on the human body are examined. The main factors are the direction, magnitude and length of time of the acceleration. How the brain, heart and circulatory system react to these causes is explained, and it is shown that physical limitations hamper the development of modern dive-bombing and combat tactics. A discussion follows of various means that have been suggested to offset the adverse physical effects, including fluid suspension, pressure suits, bandaging parts of the body and inhaling gas mixtures. It is found that positions of the body other than the usual sitting posture permit an airman to stand greater stresses, one of the best being the prone position. Numerous experimental types of aircraft are discussed, in which the pilot works from a prone position. It is indicated that this may be a solution of the problem of greater speed and performance for airplanes. *Air Tech*, October, 1942, pages 20, 21, 46, 4 illus.

Les Effets Physiologiques Dus Aux Grandes Vitesses (Physiologic Effects Due to High Speeds). E. J. Sudan. The high performance of modern airplanes causes aviators to suffer painful physical fatigues that have a tendency to develop into physiologic troubles. These troubles are not always without danger to the airplane crew. There are several varieties of discomfort: (1) plain air sickness, due to a protracted stay in high altitude; (2) decompression and compression troubles resulting from high-speed climb and descent; (3) intoxication caused by combustion gases; and (4) the grave and complex physiologic troubles due to accelerations.

The writer devotes special attention to the last and comes to the conclusion that the upright position of the aviator's body is the reason these accelerations are not better endured. The most favorable position of the aviator would be to lie either on his back or on his stomach, because in this position the heart is practically at the same level with the head and the feet. The writer recommends that designers of dive bombers and pursuit planes consider the placing of pilot and crew in such a way that their position during flight is always horizontal. *Schweizer Aero-Revue Suisse*, June, 1942, pages 229, 230, 4 illus.

Metallurgy

The Hardness Test as a Means of Estimating the Tensile Strength of Metals. W. J. Taylor. In the aircraft industry the Brinell test is not used solely for determining the property of hardness of metals as such but is used to give an idea of the tensile strength of the material. It is also used to determine the approximate tensile strength of finished parts. Owing to various impressed conditions in a particular test, hardness testing machines may not give the same values of hardness. The paper presents the writer's experience over a number of years in this field of testing. Some of the many features that may influence the results of hardness tests are given, and the estimation of maximum tensile strength is discussed. *The Journal of the Royal Aeronautical Society*, August, 1942, pages 198–209, 11 illus.

The Metallurgy of Modern Alloys. R. H. Harrington. This is the first of a series of articles on the metallurgy of alloys. It covers part of the subject of heat-treatment definitions. In the introduction, reference is made to conflicting definitions and variegated terms in this field. Treatment of the subject is taken up by the writer on the basis of the elimination of purely theoretic considerations and confusion of definitions insofar as it is possible.

To clarify definitions for standard heat-treatments, consideration is given to the three main alloy fields: (a) allotropic modifications as in the iron–carbon system; (b) the cold-worked solid solutions exemplified by cold-rolled brasses; and (c) precipitation—hardening alloys with the recently popularized copper-beryllium alloys as an example. Field (a) is covered in this article. *Heat Treating and Forging*, September, 1942, pages 468–471, 488, 489, 2 illus.

Rust-Proofing of Ferrous Metals in Light Engineering Practice. H. Silman. A considerable portion of this installment of a series of articles on the rust-proofing of ferrous metals is devoted to phosphate coatings. Various processes are discussed. These include the Parkerizing process and modified zinc processes. Methods of precleaning the steel and applying coatings are taken up. Other sections cover hydrogen embrittlement troubles, coloring processes and metallic spray coatings. *Sheet Metal Industries*, September, 1942, pages 1344–1351, 1370, 15 illus.

Forging Aluminum and Its Alloys. Attention is drawn to how the relatively new industry that has grown up around the art of forging aluminum and its alloys has quite suddenly assumed a position of vital importance in the scheme of American wartime production. Because of the wartime demand for aluminum forgings, the knowledge of experts in this field is being passed along to those who have been precipitated into the business—possibly without ever before having produced an aluminum forging. Important considerations in aluminum forging practice are set forth. Information is presented on the choice of alloys, and a table of the mechanical properties of aluminum alloy forgings is furnished. The preparation of forging stock is discussed, special reference being made to grain flow considerations. In covering die design, attention is drawn to the importance of allowing proper shrinkage and mismatch tolerances and correct draft allowance. Other sections of the paper cover forging temperatures, thickness tolerances, the lubrication of dies,

and the heat-treatment of forgings. *Heat Treating and Forging*, September, 1942, pages 462–467, 483, 8 illus.

Season Cracking of the Aluminum-Base Mg-Al Alloys. H. J. Cant. This is the concluding installment of a two-part article on the season cracking of alloys. It includes a survey of changes in the various properties according to heat-treatment and a final summary of the subject of season cracking. Changes according to heat-treatment are discussed in sections covering heat-treatment and the anticorrosion property; changes in the electrical resistance and electrical solution pressure depending on heat-treatment; changes in specific gravity depending on heat-treatment; and changes in crystalline structure depending on heat-treatment. *Sheet Metal Industries*, September, 1942, pages 1352–1354, 7 illus.

Forgings of National Emergency Steels. Waldemar Naujoks. Experience in the forging of National Emergency steels on a production basis is limited. But forging experience available on steels containing similar alloys, more alloys and less alloys makes possible reasonably accurate predictions of the possibilities and limitations of forging operations with NE steels. Information based on this experience is presented. Conditions are enumerated for the forgeability of a steel. Attention is called to the importance of grain flow in a forging. Most machine equipment parts have had in their design sufficient strength to overlook the position of fiber structure, but the aircraft industry has recognized this factor and considers it in all designs, it is stated. While the new replacement steels have a lower alloy content, they offer factors that can be utilized to produce forgings of almost equal strength for most instances and of equal strength in many cases. Details are presented on the physical characteristics of NE steels. *Heat Treating and Forging*, September, 1942, pages 460, 461, 495, 502, 3 illus.

Meteorology

Meteorological Characteristics of Thunderstorms. George N. Brancato. Because of the availability of a suitable network of observation posts, evaluation of the characteristics of thunderstorms has been made possible. The work of these stations is reviewed and studies are presented of the data secured. The actions of twelve thunderstorm formations were analyzed and three of them are discussed in detail in this article. This first of two parts deals with the duration, movement relative to gradient winds, and circulation pattern. Comments are offered on the determination of the size of storms, and some conclusions are drawn as to the amount of rainfall and the methods of forecasting thunderstorms. *Aviation*, October, 1942, pages 101–103, 292, 295, 296, 299, 3 illus.

Military Aviation

Bush-Lore for Airmen. Frank W. Lane. For the benefit of military aviators who may be forced down in the jungles or other uninhabited country in various parts of the world, detailed information is given on how to sustain life in the wilderness. Directions are given for locating natural water, if possible, and substitutes if no water is available. The writer tells how to build a fire, make weapons, arrange sleeping quarters and how to do other things necessary to keep alive and get back to civilization. *The Royal Air Force Quarterly*, September, 1942, pages 234–240.

Fortress Squadron. The British angle on the seriousness with which the U.S. Army Air Forces take their job is given after a visit to one of the units now stationed in Britain. Included are comments about the Boeing Fortress airplanes, which this particular

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unit is flying. *Flight*, August 20, 1942, pages 203, 204, 9 illus.; "Our American Allies in the Air," *The Aeroplane*, August 21, 1942, pages 214, 215, 4 illus.

Three Years of Air War. Keith Ayling. The evolution of fighter planes is traced from the first appearance of the German air force in 1914. Airplanes and armament of the Allies and of the Germans are recalled to emphasize the increase in performance and fire power that took place in the four years of the first World War. It is stated that although few historians acknowledge the fact the conflict was won for the Allies by their superiority in the air. Designs of fighters in use at the end of the war are said to have been little short of amazing. The statement is made that with the possible exception of the Boulton Paul Defiant the present war has failed to produce a single innovation in fighter design. It is shown that supercharged engines had been used in 1918, that airplanes for harassing ground troops by machine guns were widely used and that cannon, as well as machine guns, were mounted on aircraft.

Performance figures of modern fighters are quoted and the origin of several designs in racing aircraft is noted. Although the twin-engined airplane has many advantages and has demonstrated its effectiveness in this war, the writer advances the opinion that the type will not be found to be the best fighter and that it will be relegated to night interception, communications and reconnaissance work before the conflict ends. A review of the fighting airplanes of the world reveals the specialized nature of the design of each type. The article concludes with an analysis of the latest fighters and with a forecast of the ideal fighter design. *Air News*, October, 1942, pages 10–14, 34, 15 illus.

Who Said American Planes Aren't the Best? Lt. Gen. Henry H. Arnold. An analysis of United States war aircraft in action and of the men who fly them is presented by the Chief of the Army Air Forces. The magnitude of the training and recruiting program under way is stressed, and the need of public support of recruiting campaigns emphasized. The writer tells how American combat airplanes have met the test of modern war on world battle fronts. Comments are made on individual military aircraft. *National Aeronautics*, September, 1942, pages 10, 11, 40, 41, 4 illus.

Model Airplanes

"Wanted: 50,000 Models!" Canadian squadrons of the Air Cadet League are said to be capable of building the 50,000 solid scale model planes urgently needed by training stations of the Royal Canadian Air Force for aircraft recognition and range estimation. Information is furnished on the models required. *Canadian Air Cadet*, September, 1942, pages 16, 17, 4 illus.

Naval Aviation

Cata-Fighter's Birthday. An outline of the function and fighting procedures of "Cata-Fighters," aircraft launched from merchant ships to combat attacking long-range bombers. Part of an organization known as the Merchant Ship Fighter Unit, these aircraft are catapulted from merchantmen of a convoy. After dealing with attacking aircraft, the pilot of the catapulted plane has to bail out. His rescue depends upon being picked up by an escort vessel.

The M.S.F.U. is cited as an example of successful cooperation between three Services—the Royal Navy, The Royal Air Force, and the Merchant Navy. The first provides Fighter Direction Officers, the catapult and torpedomen for maintenance and signal ratings; the second provides pilots and ground crews and supplies the aircraft; and the third provides the ships and men. *Flight*, September 10, 1942, page 287, 1 illus.

The Future of Water-Based Airplanes. . . V. Capt. Frank T. Courtney. This is the fifth of a series of articles on water-based airplanes, in which the writer gives the theory that the design of waterplanes has been surpassed by that of landplanes, not because of any inherent inferiority but rather because of a neglect to develop it. This installment deals with the drawbacks of the steps and afterbodies of conventional hull designs and an analysis of the phenomenon of "porpoising." It also covers the problems and possibilities of hydrofoils. *Aviation*, October, 1942, pages 122, 123, 314, 317, 318, 321, 322, 6 illus.

Paint

Plane Dope. John S. Saviello. Information is presented on aircraft "dopes" for coating fabric-built airplanes. The most commonly used forms are named and the technique of application is described. Proper control of humidity and temperature in doping rooms is necessary and adequate air conditioning is important for satisfactory results. Provisions for guarding against the fire hazard, always present with such inflammable solutions, are discussed. The addition to these solutions of fireproofing chemicals is regarded by the writer as not totally effective. Reference is made to the use of dopes for the waterproofing of amphibian aircraft and to the application of pigmented dopes for making fighter planes practically invisible. *Air Trails*, October, 1942, pages 8, 54, 3 illus.

Chemical Paint Protects Wood from Fire Bombs. A brief description is furnished of a fire-retardant chemical invented by Drs. Walter Juda and Grinnell Jones of Harvard University. Demonstrations are described in which wood structures painted with two coats of this chemical and subjected to the heat of incendiary bombs did not burn or show material damage at the end of the test. It is believed the chemical can be used to protect barracks, hangars, hospitals, plywood planes, and other military installations and equipment. *Popular Science*, November, 1942, pages 98–100, 7 illus.

Parachutes

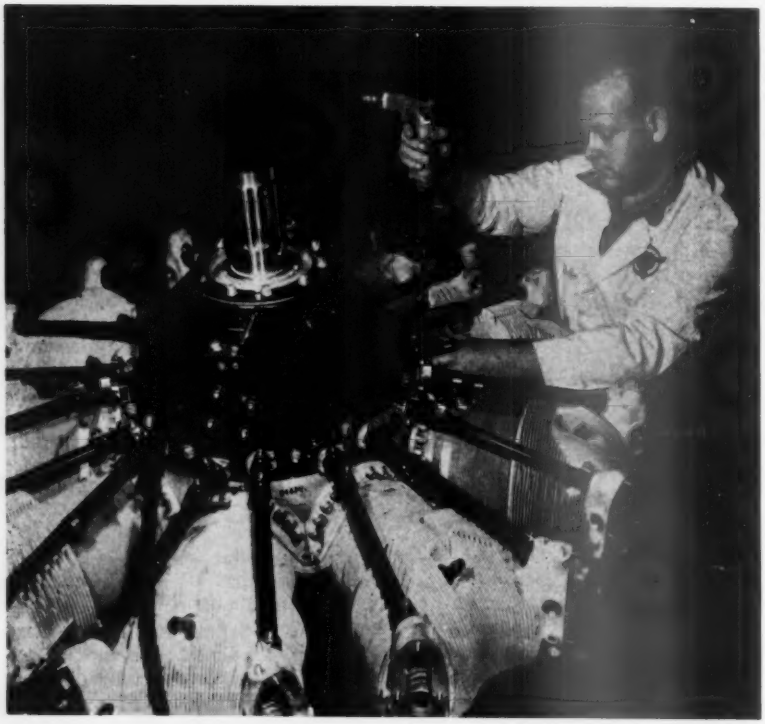
I Wanted to Jump from a Plane. By a Paratrooper as told to Corp. Stewart W. Smith. A United States Army Paratrooper describes his emotions on his first leap from a plane. He also reviews the difficult physical training program that prepared him for this assignment. His schooling in arms and military proficiency is noted and details on training towers are included. *Commercial Aviation*, September, 1942, pages 46, 48, 50, 53, 11 illus.

Tropas Paracaidistas (Parachute Troops). L. F. Contreras Toro. This article reviews the history of parachute troops, their selection for fitness, training, equipment and armament. It also cites examples of their tactical application. *Revista De La Fuerza Aerea*, April-May-June, 1942, pages 21–28.

Personalities

John Dolan, Master Sergeant. A biographic sketch is presented of a veteran Air Force maintenance man who has been recalled to active duty by the Army after four years of statutory age retirement. His services are reviewed from the time of the Spanish-American War, through the first World War to his rejoining the Army after December 7, 1941. Many anecdotes of his accomplishments under difficulties are recounted. *Air Tech*, October, 1942, pages 18, 19, 2 illus.

The Billy Mitchell Case. Melvin J. Mass. This is the second of two articles reviewing the famous Billy Mitchell controversy and the General's fight for air-power recognition. The actual trial and its dénouement is covered by this installment. The writer's conclusion is that, although the testimony supported Mitchell's ideas of



Installing plastic-made push-rod housing on a 200-hp. Cyclone engine. Plastic push-rod housing and cylinder baffles, a new development, in addition to saving aluminum, are lighter, stronger and more durable and easier to manufacture.

air power, it hardly added up to a conspiracy by the General Staff to stifle aeronautical development. Mention is also made of the Shenandoah Board of Inquiry and the Board, headed by Dwight Morrow, set up to study and recommend legislation on military and commercial aviation in the United States. *Flying*, October, 1942, pages 43, 58, 60, 62, 64.

Tom Girdler's Truce. After a brief review of the circumstances under which T. M. Girdler extended his activities from the steel business to the chairmanship of Consolidated Aircraft Corporation and Vultee Aircraft, Inc., his achievements as a production executive are recounted. Comments are made on the problems he encountered and the methods he is applying to their solution. Information is given on the facilities of Consolidated and Vultee and on the new executives who were appointed to positions in those enterprises. Results of these changes are analyzed, and a forecast is attempted of the rivalry that may develop in the production of bombers between the Consolidated and Ford organizations. *Fortune*, September, 1942, pages 89–92, 154, 156, 158, 160, 162.

Personnel

Age and the Fighter Pilot. Col. Malcolm C. Grow and Lt. Col. Harry G. Armstrong. A discussion of whether men over 25 years of age make better pilots than men under that age. After considering the factors favoring each group, the writers conclude that if they were looking for a single individual for one task they would select a man within the higher age limits, but if they were seeking several men they would select them from the younger group.

This leads to the observation that the air force's present method of having a group of younger men led by one or more of the older class appears to be the best. In favor of pilots under 25, it is stated that training records show they have greater enthusiasm for flying, greater alertness, better coordination, faster reaction time, and a greater capacity to learn and retain instruction. *Flying*, October, 1942, pages 49, 83, 84, 87, 1 illus.

Photography

Characteristics of Wide-Angle Airplane-Camera Lenses. Francis E. Washer. Negatives produced by lenses of short focal length are especially useful in topography mapping because the stereoscopic relief for contour work increases as the angle separating the image from the center of the negative increases.

The relative illumination in the focal plane was measured for a number of wide-angle airplane-camera lenses, using a method depending upon the determination of the light-transmitting area of the lens effective at definite orientations of the lens. A new factor dependent on the lens design was found to be operative in reducing the values of the relative illumination in the unvignetted portion of the field for certain types of lenses. Determinations of the resolving power were also made and showed considerable variation in performance with type of lens. The effect of basing the distortion values upon the calibrated focal length instead of the equivalent focal length was determined. *Journal of Research of the National Bureau of Standards*, September, 1942, pages 233–239, 3 illus.

Plastics and Plywood

Plywood and Plastic Construction. Harry Wilkin Perry. An explanation of the Vidal process for using plywood and plastic in the construction of aircraft. The part of the process for which origination is claimed is described as a single method of molding —by means of heat and fluid pressure, plastic-treated veneers that have been wrapped about a form—into a completely reinforced or nonreinforced shaped structure. Principal operations involved are: curving of the veneer to required shape over a solid wood form; coating the plies and reinforcements with a new thermosetting plastic which sets at a low temperature; and applying heat and equal pressure to all parts to bond them into a single integral structure. *Flight*, September 10, 1942, pages 289–291, 8 illus.; "The Vidal Process for Molded Structures," E. Eugene Miller, *Aviation*, October, 1942, pages 124–127, 299, 12 illus.

Campaign for War Business. The story of how a plastics company whose principal prewar business was the manufacture of advertising novelties saw war coming and planned a campaign that is stated to have resulted in a fourfold increase in dollar volume of business. Among the products now being manufactured by the company are parts for aircraft instruments and model airplanes for identification purposes. Details of the campaign are outlined and some products manufactured are illustrated. *Modern Plastics*, September, 1942, pages 37–41, 7 illus.

Moulded Plywood Aircraft. Production processes on a light single-engined type of plywood airplane are described. This plane is made by the Vidal principle of plywood molding. It is explained that a particular feature of this process is that the structural framework supporting the ply-

wood skin is bonded integrally with it in the same molding process. A photograph reveals how the plywood skin of a half fuselage is built up. Other pictures show the same unit before and after treatment in the pressure chamber. *Aircraft Production*, September, 1942, pages 544, 546, 547, 5 illus.

Hot Wings and Cold Set Resins. An article is presented on the use of plastic plywood in gliders. Problems of glider design are discussed. Plastic-bonded plywood now is used for the wings, tail and rudder of Army and Navy gliders, it is stated. The fuselage of these gliders is still made of steel tubing because the amount of time necessary for designing a wood fuselage would have delayed the adoption of gliders for war activities. Several makes of glider are described and glider production operations are illustrated. *Modern Plastics*, September, 1942, pages 52–55, 9 illus.

Relieving Tooling Bottlenecks with Plastics. Leonard Weiss. The Formrite method of making plastic tools and tool molds, said to have been pioneered by Brewster Aeronautical Corporation, is described. The cast method by which advantage is taken of the casting properties of certain plastic compounds in making tools and dies is compared with other processes for transferring shapes, contours, lines, holes, and other details from a part or blueprint to the tools necessary for the production of additional numbers of such parts. Advantages of this system are outlined, including the saving of strategic materials and certain claimed superiorities over steel. Characteristics are detailed under seven headings as follows: no shrinkage; cold casting; hard, smooth surface; resistant to atmospheric dimensional changes, oil and water; resistant to heat; availability and freedom of materials from priorities; and low cost of materials. Other factors mentioned are the saving of time, saving of skilled labor and machines, and suitability for subcontracting. Certain limitations are noted and precautions are advised. Applications of the method to the production of tools and aircraft parts is illustrated. *Aviation*, October, 1942, pages 114–121, 29 illus.

Plastic Plywood. George B. Parsons. Reviewed in nontechnical language, the processes of fabricating airplane parts from plywood are compared with the manufacture of similar parts of metal. Advantages of plywood construction are outlined and it is said that other favorable factors will be found as new processes are developed. *Air Tech*, October, 1942, pages 16, 17, 6 illus.

Scarfed Joints in Plywood. Thomas D. Perry. The use of scarf jointing as a means of increasing the size of plywood sheets is described. Normal plywood ordinarily comes in standard sheets, 4 by 8 ft. or smaller. War industries, and particularly the aircraft industry, are demanding sheets of larger size. It is explained that the purpose of scarf jointing is to enlarge the size of the plywood sheet and to maintain, as far as possible, its normal strength without increasing the thickness at the joint. Information is presented on standard scarf designs, single ply scarfs, cutting the bevels, and bonding the lapped ends. Drawings show how the work is performed. *Modern Plastics*, September, 1942, pages 74, 75, 116, 118, 120, 5 illus.

Production

Die-Casting Inserts Cut Costs. Herbert Chase. A method is presented for increasing the strength of die castings and reducing the cost of manufacture. It involves the use of inserts that are cast in place and become, in effect, a part of the die casting. Illustrations show the types of applications in which inserts yield specific benefits. *American Machinist*, September 17, 1942, pages 1010, 1011, 14 illus.

Prefabricating Aircraft Parts at Reynolds. W. G. Reynolds and David P. Reynolds. The Reynolds Metals Company's method of prefabricating airplane structural parts at the sheet supply source is described. An economy in machine tool time at the assembly plant, as well as savings in both aluminum scrap and needed transportation facilities are advantages claimed for this system. It is shown how shearing, blanking, and routing departments—augmented by facilities for die-making, template-making, drilling, and inspection sections—function to carry out the necessary fabricating operations. *Aviation*, October, 1942, pages 108–113, 14 illus.

A Three-way Adjustable Die. C. W. Hinman. The writer presents design details of a three-way adjustable die for the production of steel support brackets used in radio sets. The die was selected for discussion because it reveals many different phases in die engineering. It is explained that before making the die a chart or table of eight columns was compiled which gave the necessary dimensions for all the different pieces. The various phases in design are covered in detail. Drawings clarify the description. *Heat Treating and Forging*, September, 1942, pages 479–481, 3 illus.

Plane Short Cuts. Kurt Rand. Several production, machinery, and tool innovations that have resulted in a saving of time, work, and money at the Lockheed and Vega plants are described. One is the use of an electrolytic transfer process—adopted by the Boeing-Vega-Douglas combination for the production of Flying Fortresses—by which a master pattern or work template can be reproduced in 5 min. This process consists of three main operations: the preparation of the original drawing by an engineer; the scribing of the drawing on a specially treated metal sheet to make the master layout; and the transfer of the scribed layout to an inexpensive metal copy sheet from which the work template is cut.

Another agent for the speed-up of airplane construction is production illustrations. These are isometric drawings, phototracings or other perspective sketches placed on bulletin boards alongside the jigs where corresponding parts are being assembled. Among devices described are an electrical "checker," a magnetic rivet device, a device that simplifies the bending of tubing, and goggles that filter out the glare of hydrogen torches . . . . all invented by Lockheed and Vega employees. *Flying*, October, 1942, pages 38, 39, 64, 66, 76, 78, 4 illus.

Drop Hammer Technique and Innovations. Chris J. Frey and Stanley S. Kogut. Methods of augmenting the versatility and applicability of drop hammers for forming metals are presented. It is shown that operations can be closely controlled by the use of progressive dies and rubber pads to localize pressure and prevent wrinkles in the metals being worked. Fundamentals of the hammer are discussed, with advice on its operation. Details are given on the means to be employed in the control of wrinkles and the use of pressure rings, successive dies, notched dies, heat-treating, and final straightening. *Aviation*, October, 1942, pages 130–133, 285, 12 illus.

Riveting with Firecrackers. The development of explosive rivets is traced from an American patent in 1921 which was not commercially feasible, chiefly because a field did not exist for it at that time. General rules and directions are set forth for the preparation of the work, installation of the rivet and the use of the riveting iron. Specifications for repair procedures and different types of rivets are tabulated. *Air Tech*, October, 1942, pages 24, 25, 56, 3 illus.

Flow Production of Aircraft Mani-

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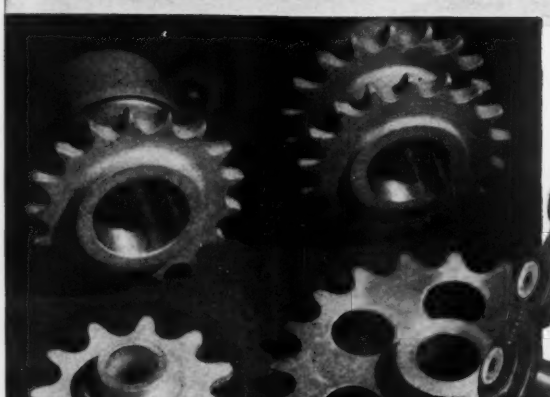

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folds. Ernest A. Moore. The factory superintendent of an aircraft company describes the application of flow production methods to the manufacture of aircraft manifolds. The job shop system used prior to volume production depended to a large extent upon the individual initiative of department heads. Nearly every phase of plant operation was involved in this change. Unlike conveyor belt or continuous assembly methods, flow production is flexible and lends itself readily to the fabrication of manifolds, it is stated. The system may be added to, cut down or modified in a manner to meet special requirements or special jobs without reducing the overall efficiency of the department. Details of the system as used by the Ryan Aeronautical Company are described and illustrated. On the flow process charts employed in the system symbols are used to designate the steps of manufacture for each part. Parts are controlled by work progress cards that are signed by each leadman after the lots called for have been filled. *American Machinist*, September 3, 1942, pages 959–969, 17 illus.

Planning and Production Control in a Limited-Lot Aircraft Engine Plant. Planning and production-control systems at the plants of the Fairchild Engine & Airplane Corporation are said to be simple but effective. Modifications have been worked out for the straight-line production method to adapt it to the requirements of operations on a moderate scale. The plan in use is held to minimize the shop paper work, yet it provides constant direction and records by which close control can be maintained. Details are set forth on the routing of a production order. Several of the forms are reproduced. Among the advantages of the system is its flexibility which permits changes in operations with a minimum of confusion. *Wings*, September, 1942, pages 127–129, 4 illus.

Boeing's PBY Production Methods. H. Eric Crawford. Methods used in the production of the PBY Boeing bomber are described and illustrated. Preparatory work, which includes all the usual operations of shearing, bending and drilling, is discussed. Development of a master schedule is outlined. A flow chart adapted from the master sequence chart actually used in the company's plant is shown. Production operations on the various components of this aircraft are explained in considerable detail. *Canadian Aviation*, September, 1942, pages 40–50, 32 illus.

Women Workers Wanted! The opportunities for women in the aviation industry are pointed out. In addition to the number of jobs that are expected to be available, the writer also claims it is an industry in which women are assured jobs *after* the war. Among other advantages he stresses are: the comparatively high wages; the many kinds of work available; no long periods of expensive technical training; the lack of high educational requirements; and the chances for advancement. *Flying*, October, 1942, pages 34, 88–90, 4 illus.

The final assembly of Douglas A-20 type attack bombers in one of the Douglas Aircraft Company's plants.

Is Kaiser Crazy? Stanley Washburn, Jr. Reviewing the accomplishments of Henry J. Kaiser and his organizations, an analysis is presented of his proposals to build a fleet of large aircraft to carry cargo to the war zones in all parts of the world. Obstacles in the form of shortages of materials and fuel for such a fleet are considered and are shown to be no greater than the difficulties that have been overcome by the Kaiser organization in its earlier production of building materials and cargo steamships. *Air News*, October, 1942, pages 15–17, 3 illus.

For Efficient Assembly. The second of a series of articles on the assembly operations at the Nashville plant of Vultee Aircraft is devoted to the forward-section assembly work. Simplification of operations and economy of motion have been applied wherever possible by means of division of the work into quantitative and qualitative classifications and standardization through work stationing. Assembly routines are explained in detail for the torque-box section, the floor-panel section, the side-panel section and the complete forward-section group through the medium of illustrations and captions. *Wings*, September, 1942, pages 130–135, 18 illus.

Simplified Control. E. C. Rechel. The article deals with production control problems in general and with methods used at the Canadian plant of Fairchild Aircraft Ltd. in particular. Long-range planning is explained in connection with efficient mass production. Tooling up for a new type of airplane involves time considerations that must be foreseen if production is not to be handicapped. The breaking down of a complicated series of operations into steps and groups of controllable size is discussed, operations being based on an assembly group system. A contrast is drawn with another plant where the assembly group method was not used. Measures for maintaining an adequate supply of parts and materials at the time and place required are detailed. A chart shows the organization and segregation of the work from material stores to final assembly. *Canadian Aviation*, September, 1942, pages 83, 84, 86, 88, 90, 5 illus.

Production—Our Home Front. William B. Stout. The writer offers the theory that it is machine-hours that will win the war and demonstrates America's superiority in this field. Claiming that this war is mechanical and that no longer is man power the chief decisive factor, he sets forth arguments to prove his point that the nation with the greatest number of machines, coupled with the

highest education and technical superiority of the men who operate these machines, will win the war . . . . and that the United States is that nation. He contrasts the attitudes of the British and Germans, giving instances of American genius for mass production. The observation is also made that the program undertaken will give this country the most highly educated industrial groups any nation has ever known. *Flying*, October, 1942, pages 31, 32, 106, 2 illus.

Boeing's Secret. George E. Haddaway. A survey of the production methods in use at the Boeing Aircraft Company. The company's plan is said to be based upon a twofold policy: making the greatest use of available machine tools before expanding facilities and maintaining the most thorough inspection system possible. The article explains how, instead of one long assembly line carrying practically the entire airplane, Boeing uses several long but compact production lines for major assemblies in which each component part of the plane is virtually completed before final assembly has begun.

Several Boeing innovations in design and tooling are also described. These include a circumferential hydropunch, an automatic aluminum spot-welding table, a speedy die-making process, a change in the rear-gunner's door, and retarding the action of heat-treating Dural. *Southern Flight*, September, 1942, pages 36–39, 2 illus.

Subcontracting from Scratch. Eugene K. Gray. Details are given on how by the application of ingenuity and hard work an aircraft parts subcontracting firm grew within a year and a half from a small nucleus to a quarter-million dollar organization. The article tells how old equipment was utilized by designing special jigs and fixtures. This rehabilitation of machinery included belt-driven engine lathes and screw machines. Part of the organization's success, it is stated, also depended upon the employment of unskilled labor. *Aviation*, October, 1942, pages 189, 191, 192, 2 illus.

Conveyor Tracks for Dollies Speed Production of Cargo Planes. Arthur E. Petzon. Application of dollies equipped with V-casters riding on grouted rails has been found to facilitate production of various parts of the P-40 and has been adapted also for the Commando at the Buffalo plant of Curtiss-Wright. Advantages of this form of conveyor are shown and the methods of installing the apparatus are described. *Wings*, September, 1942, pages 136, 137, 4 illus.

A Mechanised Light-Alloy Foundry. Part III. This article on the production of Rolls-Royce aircraft engines is the third of a series. It covers operations in a foundry that is fully mechanized, said to be an almost unique feature for light-alloy work. Manufacturing operations in the core department and foundry are described and methods of die casting are outlined. It is the policy of the company to employ coremakers for coremaking only, auxiliary operations being dealt with in departments devoted solely to this work. This permits core pattern equipment to be kept in full-time operation. Manufacturing activities discussed include gas testing of the cores, molding sand preparation, batch sand making, melting practice, and core removal and fettling. Operations on individual parts of the engine are detailed. The electrical equipment is described and heat-treatment methods are covered. *Aircraft Production*, September, 1942, pages 548–558, 28 illus.

Propellers

Propeller Forces Due to Yaw and Their Effect on Airplane Stability. L. B. Rumph, R. J. White, and H. R. Grummann. Forces produced by a propeller operating at an angle to the air stream or being subjected to certain displacement velocities with respect to the air stream were calculated by Harris and Glauert in 1918. Recent tests on a propeller of modern plan form has shown that the theory of Harris and Glauert when used *without their empirical constant* predicted only half of the force in yaw as indicated by the tests. A new theory is presented here which has improved the agreement between the predicted and measured values of one of the force derivatives for the propeller tested and is believed to be more desirable for design calculations.

This method is based upon the same assumptions used by Harris and Glauert but includes the modified lift produced by an airfoil when operating in an oscillating air stream. The equations are in a different form than given by Harris and Glauert—they depend mainly upon the propeller blade form and clearly indicate that propellers having a wide root chord section will produce a greater side force due to yaw than would be realized with a propeller blade having a narrow root chord. This is an interesting conclusion, since a high-altitude pusher-type airplane that will probably require a propeller with a wide root chord will be favored from the stability point of view in comparison with a similar tractor-type airplane.

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Journal of the Aeronautical Sciences, October, 1942, pages 465–470, 6 illus.

Propeller Maintenance. R. L. Scheuerman. Hints are given as a guide in locating and correcting troubles in propellers, especially under the difficult conditions prevailing in combat zones where full facilities are not available. Measures are described for establishing the degree of bend to determine whether a cold straightening job can be performed in the field and for removing nicks, scratches and dents. Suggestions are made for analyzing troubles in propellers reported to be operating improperly, since such faults may be traced to sources not in the propeller itself. Other propeller troubles are defined and remedies are outlined. *Air Tech*, October, 1942, pages 42, 44, 46, 4 illus.

Bent, twisted and bullet-damaged propeller blades from the fighting and training fronts of the United States Air Forces are brought to the Pawcatuck, Conn., plant of Hamilton Standard Propellers Division, United Aircraft Corporation, for straightening and return to active duty.

Radio

German Radio Equipment. This is the third of a series of articles on German aircraft radio equipment. It covers the type FUG 16 equipment used in the Ju 88 and Do 217. This equipment consists of a communication transmitter and receiver which, with the motor generator, are located inside the fuselage on the starboard wall just aft of the D.F. receiver. It is explained that the tuning controls are not accessible in flight and there is no provision for fitting of remote tuning controls. The equipment must, therefore, be used on one channel only, preset on the ground. The tuning dials of both transmitter and receiver have the frequency of 39.2 megacycles specially engraved in red. The pilot controls the operation of equipment. It is pointed out that the transmitter, receiver and associated circuits are built in a single unit, which is an innovation in German design. Circuit diagrams, performance data and illustrations clarify the text. *Aircraft Engineering*, August, 1942, pages 230–234, 9 illus.

Airport Traffic Control by Visual Signals. Ewan D. Boyd. Part three of a series on flying the airways of Canada, this article surveys some of the major principles of airport traffic control. It is concerned with control procedures for nonradio equipped aircraft. Explanation is offered on how such aircraft should approach, land, and take-off from airports and what signals are necessary for safe passage. Emphasis is placed on the importance of the control tender under these conditions. Some of the primary topics dealt with in this article are: inbound aircraft, the correct circuit, standard air speed, final approach, a "pull-up," acknowledging signals, wind shift, landing, take-off, grass area traffic, and clearing the runway. Others include: taxiing in, outbound aircraft, night flying and emergency landing. *Commercial Aviation*, September, 1942, pages 62, 64, 66, 68, 70, 10 illus.

Radio . . . . Pilot's Best Friend. John A. Doremus. As a suggested introduction to studying aircraft radio, the International Morse Code and how to learn it are outlined. The necessity for learning the code is indicated by the following reasons: First, it must be known in order to identify the range stations whose signals are used; second, when communicating with ground stations through difficult conditions of noise and static, code signals can generally be understood when voice transmission is garbled beyond recognition; third, many stations, such as ships at sea, are equipped to send code signals only. *Yankee Pilot*, August, 1942, page 8.

Research

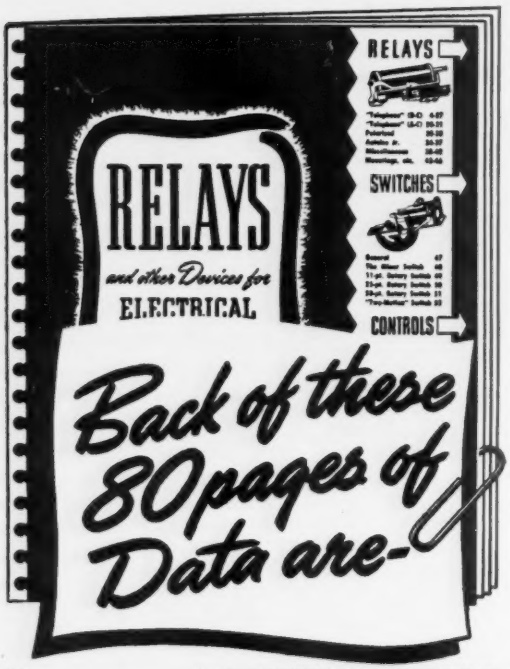
The Role of Surface Chemistry and Profile in Boundary Lubrication. J. T. Burwell. The effect of both the chemistry and geometry of bearing surfaces on the performance of bearings under the conditions of boundary lubrication is discussed. In grading surfaces for lubrication performance, it is pointed out that at least one other quantity in addition to the root-mean-square roughness should be specified. It is noted that loose material or "fuzz" is found on all commercially finished surfaces. Data presented show that one function of addition agents in oil is to mitigate the bad effect of poor surface finish. The writer continues with a discussion of the affinity of lubricants for metal surfaces. Methods for experimentally measuring this property are outlined, together with results. It is shown that a high affinity or "wettability" is a necessary, but not a sufficient, condition for a good boundary lubricant. *S.A.E. Journal*, October, 1942, pages 450–457, 4 illus.

Stress Analysis

A Practical Method of Allowance—for Shear Lag. John De S. Coutinho. The calculation of stresses in a semi-monocoque cantilever wing is discussed from an engineering-office point of view.

The influence of various factors on the stress distribution in thin-walled structures is considered, especially the effects of shear lag for which a simple empirical method of allowance is suggested. The use of the method is illustrated in the example of a box-beam wing, and the results of the calculations are checked by stress measurements on a full-size test specimen. *Journal of the Aeronautical Sciences*, October, 1942, pages 471–477, 14 illus.

Torsional and Flexural Buckling of Bars of Thin-Walled Open Section Under Compressive and Bending Loads. J. N. Goodier. An analysis is presented on the observed behavior of torsionally weak columns in buckling by twisting alone or by twisting and bending. The analysis is based on Wagner's hypothesis. The theory is simplified and extended to the general section where results simpler than some already obtained by Kappus are given. It is further extended to bars, restrained by flexible sheets, and bars with constrained axes of rotation. Wagner's hypothesis is applied to the problem of lateral buckling where it yields the accepted theory for symmetric sections but indicates results of novel form for unsymmetric cases.



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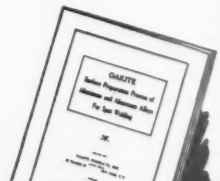

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Similar results are obtained in the problem of eccentric thrust, whatever the section. *Journal of Applied Mechanics*, September, 1942, pages A-103–A-107, 7 illus.

Distribution of Stress in Built-In Beams of Narrow Rectangular Cross Section. F. B. Hildebrand and Eric Reissner. The problem of the distribution of stress in cantilever beams is discussed with particular reference to the situation where the narrow rectangular flange cross section has one end of the beam rigidly built in. Because of the apparent difficulty in obtaining an exact solution of this plane-stress problem, an approximate solution is derived by applying the principle of least work. The writers assume a third degree polynominal instead of the linear normal stress distribution of the elementary beam theory, and they then determine the spanwise variation of this stress curve by means of the calculus of variations. Numerical results with regard to the stress at the built-in end of the beam were obtained which showed dependence upon the following factors: (a) the span-height ratio of the beam; (b) the flange area-web ratio of the beam; (c) the distribution of load along the span; and (d) Poisson's ratio.

The conclusion is reached that the deviation from the results of the elementary theory may be considerable when the distance of the center of gravity of the load curve from the built-in end of the beam is less than two times the height of the cross section of the beam. *Journal of Applied Mechanics*, September, 1942, pages A-108–A-116, 9 illus.

Buckling of Semimonocoque Structures Under Compression. Tsun Kuei Wang. The semimonocoque type of airplane fuselage represents a stiffened cylindrical shell. This paper presents an investigation of the strength of such a structure under the action of uniform axial compression. It is assumed that the cylindrical structure is a thin tube of circular cross section and that reinforcements consist essentially of a great number of uniform longitudinal stiffeners and a great number of uniform transverse rings. The writer shows how the critical value of the compression load for the buckling of such a structure can be determined. *Journal of Applied Mechanics*, September, 1942, pages A-117–A-121, 3 illus.

Testing

Testing Aircraft Cowl Fasteners. O. J. Poupitch. A discussion of the tests to which aircraft cowl fasteners are subjected in order to determine their ability to perform their design function and to promote their development from the initial design stage. In conformance with AN specifications, they must undergo the following tests: initial tension, ultimate tension, shear, endurance or fatigue, vibration, locking and unlocking torque, and curved-sheet application. *Aviation*, October, 1942, pages 128, 332, 2 illus.

Engine testing at sub-zero temperatures at Wright Aeronautical Corporation. Sub-zero tests include testing of new fuels, lubricants and electrical equipment.

Testing Equipment

Production Testing Facilities of Allison Division of General Motors. H. J. Buttner. The background of present engine testing facilities is traced. It is noted that the latest type of engine test stand is merely an elaborate development of test stands first used for Liberty aircraft engines. Factors involved in the choice of a basic design for production stands are considered. Features of design discussed include general building arrangement and construction, engine stands and mounts, operational equipment, temperature-regulating equipment, plumbing, filters, weighing equipment, instrumentation, and sound treatment. Consideration is given to mount problems viewed from the standpoint of design, vibration and endurance. In the layout of heat exchangers, the importance of rapid warm-up and economical water usage is emphasized. It is stated that full-flow filters have proved worth while in the oiling system. The operator's control layout and sound absorption tests are described and illustrated. *S.A.E. Journal*, October, 1942, pages 444–449, 11 illus.

Tools and Equipment

To Get More from Available Tools: Duplicate Your Jigs, Fixtures or Tables. Herbert Chase. Examples are cited showing how production can be speeded up from available machines, principally by reducing the time required for loading and unloading. Certain devices such as quick-change chucks and rapid-acting clamps are quite generally understood in the industry, but numerous other fast-acting elements are less familiar. Among these, information is given on jigs and fixtures that can be loaded while the machine is operating, special feeds, ejecting devices, multiple or stack cutting of thin sections, movable tables and several other kinds of apparatus. The application and operation of such production helps are explained. *Wings*, September, 1942, pages 138–140, 5 illus.

Training

Bodyguards for Bombers. Young candidates, selected from civilian pursuits if they meet the physical requirements, are trained to be gunners on bombers by actual instruction and practice in shooting. Starting with 0.22 caliber rifles like those used in a shooting gallery, students are taught to shoot with pneumatic machine guns that compare in firing speed with powder-charged guns. Further practice is obtained with shotguns and skeet traps, shooting clay pigeons from moving Army trucks traveling over rough and rutted roads. Standard machine guns are then mastered, from fixed positions and various kinds of moving mounts, after which the student gunners learn to shoot from airplanes at ground and flying targets. Their duties and responsibilities after they become full-fledged aerial gunners are detailed. *Air News*, October, 1942, pages 28–30, 13 illus.

Why Waste This Gas? William D. Strohmeier. An Army flight instructor urges that light planes instead of primary trainers be used for initial training of cadets. Arguments advanced in favor of the plan are: great economy of vital gasoline; less noise to fluster the cadet; closed cockpits which permit better communication between instructor and student; saving in cost of equipment, maintenance, and repair; and less use of critical materials. He refutes the theory that light-plane pilots cannot make the transition to larger equipment of a military type and contends that the smaller planes are more adaptable for acclimating to the airmen who have never flown before. He suggests that the plan be followed as a complement to present training methods by adding to the present primary course a preliminary course, using light planes, for cadets with no pre-

vious "time." *Air Facts*, October 1942, pages 30–36.

Down to the Sea in Blimps. Ens. Earl E. Burton. The training received by naval candidates who wish to become crew members of submarine hunting blimp patrols is detailed. Lighter-than-air training is given at the Naval Air Station, Lakehurst, N. J., where the first period of instruction consists of primary ground school usually lasting about ten days. The lecture curriculum during this time covers aerology, aviation medicine, naval customs and traditions, seamanship, naval command and procedure, supplemented by physical exercise and military drill.

The cadet then passes on to an actual flight training phase, conducted on a system of alternating flight and ground-school days. At ground-school classes he studies aerostatics; airmanship; free balloons; lifting and fuel gases; ship maintenance; ground handling and mooring; power plants; aerology; navigation; instruments; ordnance and gunnery; strategy, tactics, and mission; communications and parachutes. The practical application of classroom problems is observed on his flight schedules. When the ground school and primary flight time are completed, the cadet enters advanced flight training. Now he not only actually pilots the airship, but also collaborates on beam flying, instrument flying, contact problems and navigation. After he has successfully completed 150 hours in advanced flight training, he is commissioned as an ensign and designated a Naval Aviator. *Flying*, October, 1942, pages 24, 25, 97, 4 illus.

Calling More Pilots! Details of the Army's pilot training program and how it was developed are presented. The different courses provided are given. *National Aeronautics*, September, 1942, page 23, 1 illus.

Britain's Air Cadets. Keith Ayling. The history of Britain's air cadet movement is outlined and the accomplishments of the Air League of the British Empire are described. The air training corps, founded for schoolboys before the war by air-minded individuals, now has nearly 200,000 members and has supplied thousands of men to the Royal Air Force, it is stated. Illustrations of cadets in training supplement the description. *Air Trails*, October, 1942, pages 24, 54–56, 4 illus.

Glider-Pilot Training. The course of training for glider pilots selected from the British Army is outlined. Also included in the discussion are comments on the Royal Air Force instructors giving the course, the type of personnel taking the course, and the equipment used.

The initial training takes place at an Elementary Flying Training School where extra stress is laid on approaches, map reading, night flying and simple navigation. The student glider pilots are then posted to units at which they are taught first to handle gliders, both on tow and free, and later specialized tactical handling. *Flight*, September 10, 1942, pages 277–279, 10 illus.

Army's "Peeping Toms" See All. This article describes how Army officers are trained in observation techniques at Brooks Field, Tex. These men are destined to become members of observation squadrons in one of the five air support commands. There is an air support command for each of the four armies and one for the armored forces. The training of observers, the duties they must perform, and the equipment used in observation work are described in considerable detail. A large K-3B camera used by observers is illustrated. *National Aeronautics*, September, 1942, page 33, 1 illus.

School for Destruction. Corp. Jack Angell. The Armament School at Lowry Field is described, with special attention to the course of training

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given there for the armorers of the Air Forces. These are the men who are responsible for the proper operation of the guns and bomb-dropping mechanism of the Army's fighters and bombers. The curriculum is traced from the basic instruction in the electrical apparatus of the plane, chemical warfare, machine guns, gun sights, to bomb racks and power turrets. Achievements of men from this school are recounted. *Air Tech*, October, 1942, pages 35–37, 56, 8 illus.

Pilot Training Goes to the University. David C. Adkins. The Controlled Flight Officer course at the University of Vermont, conducted by the Northeast Airlines Pilot Training Division, is described. Indicating that this collaboration of university and civilian flight training school is establishing new educational procedures, the writer tells what the course consists of, the qualifications required, the varied types of students who take it. He also discusses the organization of the school, the men in charge of it, and the equipment that is used.

Under the direction of the C.A.A., the Controlled Flight Officer Course leads to specific jobs for men qualified by the training to enter under contract into noncombatant service. It is made up of three parts: in the first, there are pre-enrollment examinations and tests which last a week; in the second, preliminary academic ground-school, link training, and single-engined flight instruction; in the third, advanced ground-school work and multi-engined flight training. *Yankee Pilot*, August, 1942, pages 4–6, 17, 5 illus.

You're Going to Fly—and Like It! Robert H. Hinckley. The future of aviation in America is described with special reference to the thousands of postwar jobs that will be available to young Americans who daily are becoming more air-minded due to the exigencies of war. The opportunities for careers that will be opened after the war by air-line expansion and glider development are set forth, and it is predicted that there will be an expansion in the number of aeronautical engineering courses offered by colleges. *Air Trails*, October, 1942, pages 22, 48–51, 1 illus.

Take It, Mister! Corey Ford and Alastair MacBain. With emphasis on the role played by the flight instructor, details are given on the Army Air Force Primary School training course at Carlstrom Field, Fla. The article tells how important the instructor's job is in turning out the thousands of pilots necessary for the war program, relates the knowledge he must have, and describes the psychology and judgment that must be applied in impelling each pupil to his best effort. *Collier's*, October 10, 1942, pages 46, 47, 49, 7 illus.

Scott Field AAF Radio University. A brief description covers the activities of the Army Air Forces' radio school, called the world's largest institution for instruction in radio communication. The school's aim is to train selected men in the operation and line maintenance of aircraft radio equipment and in the installation, operation and field maintenance of allied tactical ground equipment. The three major periods into which the 770 hours of instruction are divided are radio operation, fundamentals and radio instruments. Each section is described briefly. *Air Tech*, October, 1942, pages 38, 39, 14 illus.

Tuskegee. An account of Tuskegee Army Flying School where negro pilots, skilled technicians, air mechanics, photographers, radio operators and weather men are being graduated. The development of the school is traced, a description given of its physical setting, and mention is made of the several officers in charge. *Dixie Air News*, September, 1942, pages 15, 20, 3 illus.

Let's Go to Glider College. John T. Lynch. An account is given of the establishment and operations of what are said to be the only training classes in the United States where college credit is being offered in courses on how to build gliders and fly them. The new school has been made a part of the University of Denver Junior College and also of the University College, which is the adult-education school of the institution. One class has been established for boys and girls under 18 years of age; another, for those over 18; and a third, at the Lowry Field technical training school of the Army Air Forces, is for enlisted men as an extracurricular activity. The students are taught the practical aspects of construction by building their own gliders and then are given instruction and practice in actual flight. *Model Aviation*, September, 1942, pages 8, 9, 3 illus.; *National Aeronautics*, September, 1942, pages 12, 13, 3 illus.

Putting the Power in Manpower. H. R. Ingraham. Details are given on the Navy's twelve-week preflight training course to increase the physical endurance and strength of navy pilots. Called the toughest physical training course in American history, it is being given at four centers—the University of North Carolina, Chapel Hill, N.C.; the University of Iowa, Iowa City, Ia.; the University of Georgia, Athens, Ga.; and St. Mary's College, Calif. With the North Carolina center as an example, the article discusses the program, which is molded chiefly on ten basic sports altered to fit wartime purposes. Diet also receives consideration. Trends to adopt similar programs in our educational systems are also noted. *Flying*, October, 1942, pages 48, 108, 116, 1 illus.

Navigation. Lt. Lynn D. Poole. The program of the Aviation Navigation Training School at Mather Field is described. Details are given on the procedure of schooling U.S. Army Air Force navigation cadets in the four methods of determining positions—pilotage, radio aids, celestial observation and dead reckoning. After a period of orientation, the science of each method is first taught to the student in the classroom and then put to practical application in the air. Among the subjects studied are mathematics, meteorology, map reading and map making, radiology, and astronomy. *Dixie Air News*, September, 1942, pages 8, 21, 1 illus.

Lightplanes Make the Grade with the Field Artillery. Information is submitted on the Air Detachment of the Field Artillery School at Fort Sill where officers and enlisted men are trained to become pilots for artillery operations only. Flying light planes and remaining behind their own lines at all times for safety, the work of these men will consist primarily of the spotting of artillery bursts while acting as elevated observation posts for the conduct of artillery fire. The article states that each artillery battalion will have two airplanes, one officer pilot, and one enlisted pilot and mechanic.

Pilots taking the advanced course at Fort Sill's Post Field come from two sources—military personnel of the ground force and C.P.T. The course is divided into three sections. In the first section men are trained in short field techniques and low-altitude maneuvers; in the second, field maintenance and repairs of liaison type airplanes; and in the third, tactical employment and camouflage. *The Sportsman Pilot*, September 15, 1942, pages 10, 11, 45, 5 illus.

High Into the Sun. As typified by the curriculum at Southeast Army Air Forces Training Center, the training of a U.S. Army Aviation Cadet is described. The diversified backgrounds of these men and the variety of types are noted, with great praise accorded to their spirit and determination. Phases of ground-school instruction and physical preparation are touched upon, but the main concern of the article is with the attitude of the men toward their job. *Collier's*, October 3, 1942, pages 61, 65, 66, 1 illus.

Post-War Aviation. Capt. Maxwell W. Balfour. A prediction of

what the postwar aviation school will be like, with the present Spartan School at Tulsa, Okla., presented as a model of such a school. The writer claims that the large institutions now being built up as a result of the volume of work provided by the C.P.T. and Air Force programs will probably drive the small operators out of the business. He states that superior equipment, personnel, and better organization will account for this. *Dixie Air News*, September, 1942, page 9, 1 illus.

1000 Men are Coming on Tuesday. Frank J. Taylor. An article telling how aircraft companies responded to Lt. Gen. Henry H. Arnold's order for the mass training of ground crews at company plants. Reasons for the success of the undertaking are enumerated. Aircraft factories essentially are enormous technical schools with expanding courses that constantly train men for more skilled jobs, it is pointed out. *The Saturday Evening Post*, September 19, 1942, pages 18, 36, 39, 2 illus.

Warfare

The Dieppe Operations. An account of the part played by the United Nations air forces in the Dieppe raid. Offensive, defensive, liaison and support operations were all successfully carried through. This report claims as a result that at least one-seventh of the total Luftwaffe strength in Western Europe was destroyed while approximately one-third was put out of action. The maneuvers also provided a new opportunity for the Royal Air Force to try new close support tactics and to prove the possibility of maintaining emergency landing grounds close to the front line.

The fact that Italian machines bearing Italian Army markings were sighted leads to an expression of the belief that the supply problem of the Luftwaffe may be even more serious than is realized. *The Aeroplane*, August 28, 1942, page 250, 1 illus.

"Cologner Treatment." Exceedingly heavy types of mass bombing raids are known to British flyers as "Cologners." In this article the writer describes Britain's recent mass air raids on Germany and German-occupied territory with special attention to the raid on Düsseldorf, said to be the most concentrated air attack since the war began. *Canadian Air Cadet*, September, 1942, page 19, 3 illus.

It's Hell Over China! Douglas J. Ingells. In an interview reported by the writer, an officer of the first contingent of Flying Tigers, the American Volunteer Group whose exploits over China have become famous, furnishes a graphic picture of fighting in that theater of the war. *Air Trails*, October, 1942, pages 14, 15, 40, 42, 44, 45, 2 illus.

Cologne Raid. Squadron Leader J. DeL. Wooldridge. An R.A.F. bomber pilot who took part in the 1,000-plane raid upon Cologne relates his experiences during the expedition. The narrative follows the bomber from its take-off until it returns to its home base. *Flying*, October, 1942, pages 30, 112, 1 illus.

Mines in the Sea Lanes. An account of how mines are laid by British airplanes off the enemy coasts. Although obsolescent and out of production, Handley Page Hampden bombers are still giving excellent service in this capacity. Under conditions requiring careful navigation, they make their long journeys to drop mines from varying heights. Canvas parachutes are used to break the fall of the mines, and the crews of the Hampdens are careful to see that the mines are dropped exactly over the selected spots. *The Aeroplane*, September 4, 1942, pages 276, 277, 4 illus.

Don't Count Out the Battleship. Bernard Brodie. Admitting that the airplane is an instrument of almost miraculous accomplishments, the writer takes exception to the view that the battleship has no place in modern warfare. Special reference is made to theories of Major de Seversky. It is stated that the airplane should be put in its proper position in the scheme of things if for no other reason than to derive from it its maximum effectiveness.

It is pointed out that aircraft protection of fleets is essential near powerful land-based air forces, but there are many important hostile coasts with no concentration of air power. Attention is called to the fact that Japanese invasions were all sea-borne and that landings were covered by the guns of warships and fleet-borne aircraft.

Discussing the importance of the Navy in the control of maritime transportation, it is noted that blockades are carried out by navies, and that, while airplanes have an important place in action against enemy submarines, they cannot carry depth charges to destroy them when submerged. Figures show that battleships have fared better under air attack than any other type of war vessel. *Saturday Evening Post*, September 19, 1942, pages 14, 15, 63, 65, 66, 3 illus.

The Ramming Russians. Lt. Robert B. Hotz. A study of airplane ramming, used by the Russians as a definite tactic from which both pilot and plane may escape undamaged. Employed against a crippled aircraft, skillful piloting and utilization of the opponent's lack of maneuverability combine to execute a successful ramming operation with a minimum of harm to the attacker. Three types of ramming are designated: the direct blow, hitting the enemy plane with a part of a Russian plane, and clipping control surfaces by slight propeller contact. The experiences of several Russian pilots who have successfully executed these tactics are related. *Flying*, October, 1942, pages 32, 100, 102, 1 illus.

An Open Letter to the Unholy Three. E. V. Rickenbacker. The president of Eastern Air Lines presents statistics in refutation of the critical opinions expressed by some writers, commentators and others with respect to the quality and performance of American combat aircraft. Figures are given on the production of airplanes and on the number of raids in which American planes have participated. Comments are made on the training facilities for pilots and on the performance characteristics that are required of specific types of aircraft, with reference to outstanding accomplishments against the Japanese. The opinion is expressed that American military airplanes and pilots are among the best in the service of the United Nations. *Rockefeller Center Magazine*, October, 1942, pages 14, 15, 29, 4 illus.

Entwicklung des Luftkrieges (The Development of the War in the Air). This article reviews the large-scale air raids on Germany and expresses doubt whether they will have any effect on the outcome of the war.

It is stated that according to newspaper reports the Russians are using a new type of bomb against "panzers." This is a rocket-propelled bomb that gets its initial speed from the airplane proper while the rockets increase its speed greatly, thus enhancing penetrating force. *Schweizer Aero-Revue Suisse*, June, 1942, pages 244–246, 2 illus.

The Inoffensive Battleship. Based on the contention that battleships are not proving their worth, the question is posed why they aren't converted into aircraft carriers. The possibilities and advantages of so doing are considered.

The writer offers an alternative suggestion—to bank our battleships in shallow water along the French and

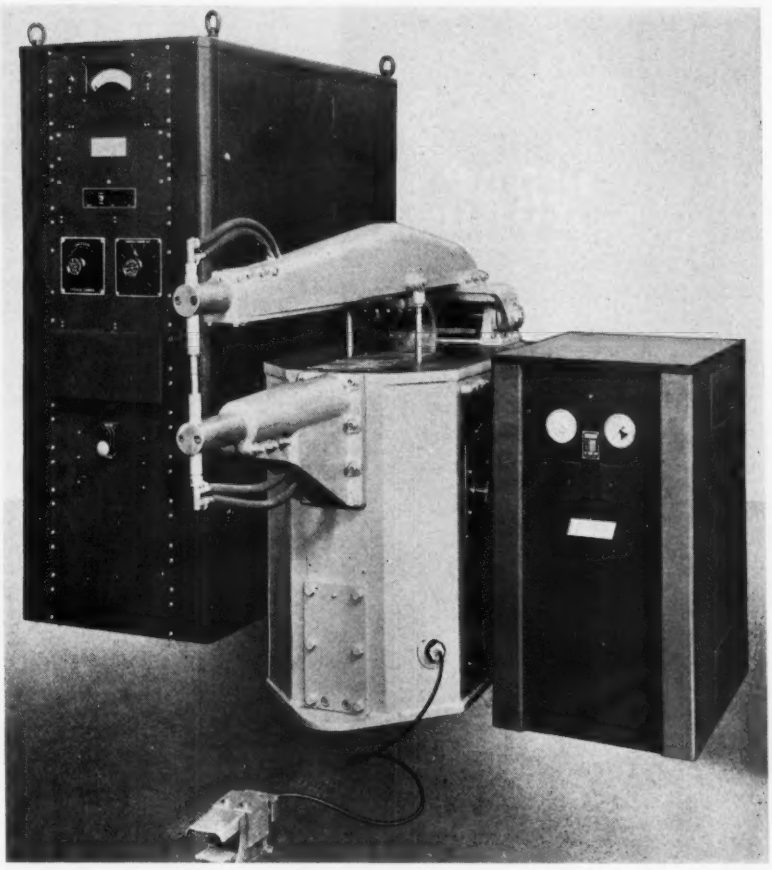
Belgian coasts and use their guns for an artillery broadside in preparation for an invasion. Sitting solidly on the bottom of the channel, he claims, they could not be sunk and could be used as land fortresses. *Flying*, October, 1942, pages 33, 78, 80, 83, 1 illus.

Norwegians over Dieppe. A report is made on the toll of enemy aircraft taken by Norwegian airmen who took part in the recent Dieppe raid. They are credited with 14 destroyed German aircraft, four others that were "probably" destroyed, and 13 damaged. The spirit of the Norwegian Air Force during the raid is typified by an account of the heroic experience of one of their 19-year-old pilots. *Flight*, September 10, 1942, pages 280, 281, 5 illus.

Welding

Progress Report on the Use of Flash Welding as a Means of Fabricating Aircraft Structural Parts from X-4139 Steel. R. P. Della-Vedowa. This paper contains a report on work undertaken for the purpose of establishing the butt flash welding of X-4130 steel as a production process for joining aircraft structural assemblies. Information was derived for setting welding machines for various sizes of tubing, presented in the form of curves that can be used to find the proper setting of the machine for welding any cross-sectional area, thickness or diameter of tubing within the capacity of the machine. The report consists of a description of the process, a history of the development and the results of a preliminary investigation, after which the procedure and results are discussed in detail. It is concluded that butt flash welding is a satisfactory and desirable production process for welding X-4130 steel in aircraft structural assemblies because it offers the following advantages: (1) good consistency; (2) weld strength equal to that of the tube itself (in tension); (3) cost economy; (4) weight economy; (5) close tolerances and elimination of warping; (6) possibility of "finish machining" parts prior to welding; (7) since the process is semiautomatic, less-skilled operators are required. *The Welding Journal*, September, 1942, pages 421-s–426-s, 11 illus.

Radiography of Spot Welds—I. Robert C. Woods, John C. Barrett, and T. W. Dietz. In the first installment of a two-part article intended to clarify some of the factors involved in X-ray inspection of spot welds, the writers discuss the "rings" and "sunbursts" observed in radiographs of spot-welded metals. The "rings" around the periphery of a spot weld are explained and their origin is traced.



"Progressive" Rocker Arm Welding installation. (*See* "From the Industry.")

Reasons for this phenomenon are explored and experiments are described by which it was studied. Comments are made on the effects of the type of welding process and the relation of the rings to the quality of the weld. The writers present evidence that radiographic techniques are capable of revealing structural changes in spot welds and show that aluminum and magnesium alloys are ideal radiographic subjects. It is observed that useful data can also be obtained by similar methods when applied to other metals and alloys. *Metals and Alloys*, September, 1942, pages 442–447, 11 illus.

Recommended Practices for Inspection of Fusion Welding. Detailed recommendations are given for the purpose of establishing standards of fusion welding inspection. Sections are devoted to the qualifications and duties of welding inspectors, the inspection and testing of welded structures, the welding characteristics of ferrous metals and of nonferrous metals. The latter section gives attention to copper, aluminum and nickel, and their alloys. With reference to aluminum, specific treatment is accorded to external visual inspection, internal inspection, mechanical tests, repairs, appearance, undercutting, cracks and oxidized metal. Visual and X-ray inspection, mechanical tests and repairs are covered in connection with nickel and its alloys. Another section deals with etching reagents, including those for the nonferrous metals and alloys, such as chromium-nickel alloys, copper and aluminum alloys and Monel, nickel and Inconel. *The Welding Journal*, September, 1942, pages 613–624.

Fabricated Stainless Steel Tubing. H. S. Card. A discussion is presented of the application of welded stainless steel tubing for the coolant circulating system of a liquid-cooled aircraft engine. Typical parts of the assembly are illustrated, showing the varied operations involved in fabricating them. Problems were solved in connection with the welding and mechanical working properties of the material, as well as the metallurgic effects of these fabricating operations. The conclusion of this brief study is that the limitations on the fabrication of welded stainless-steel tubing are no more severe than on other types of tubing and that scrap losses are minimized. *The Welding Journal*, September, 1942, page 625, 2 illus.

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Tremendous Trifles. A graphic presentation of methods for saving industrial materials and finding substitutes. It shows, among other things, how vast quantities of materials can be saved by changes and improvements in methods of making small parts; how stamping can be substituted for machine work or forging; how steel can be used in place of brass; how steel wire welded on a hub can save time and material when substituted for bronze and aluminum castings; and how certain machine operations can be employed instead of other more complicated operations.

National Advisory Committee for Aeronautics

Thermal Theory of Combustion and Explosion; III. Theory of Normal Flame Propagation. N. N. Semenov. Translated from *Progress of Physical Science* (U.S.S.R.), Vol. 24, No. 4, 1940, this paper is concerned with the process of combustion in homogeneous mixtures taking place in a very thin zone of the flame front. The first part explains experimental data on flame propagation. It shows the difference between normal combustion and detonating combustion and develops a method for measuring the velocity of flame propagation. The second part presents an analysis of the old theoretic views on flame propagation and the third part puts forth a new theory on the same subject. The fourth section is devoted to a confirmation of the theory for simple reactions, a theory of combustion of explosive substances and particularly nitroglycol. In the fifth section, a check is presented of the theory by the example of a chain oxidizing reaction. This is the theory of flame propagation in carbon monoxide, air, and mixtures of carbon monoxide and oxygen. It is concluded that the new theory of combustion, through the choice of the form of kinetic law for the rate of oxidation of carbon, which law contains only a single arbitrary constant, rationally accounts for all the numerous experimental results on the flame propagation of carbon in air and in oxygen, quantitatively in most cases and qualitatively in only a few cases. By closely examining the mechanism of the oxidation of carbon, an attempt is made to find the required kinetic law. *N.A.C.A. T.M. No. 1026*, September, 1942, 74 pages, 21 illus.

The Formation of Ice on Aircraft. W. Bleeker. This paper, translated from *Meteorologische Zeitschrift*, September, 1932, has reference to the finding of a definite physical solution of the problem of ice formation on aircraft. Most authorities agree that supercooled water droplets play an important part in the phenomenon, but they fail to specify the exact manner in which this occurs, it is explained. Reference is made to present theories on the subject and their weaknesses are demonstrated. One theory, it is shown, does not explain supercooling and fails in a quantitative study. Another theory considered embodies the assumption that the ice coating on an airplane is dry and remains so—an assumption with which the writer does not agree. The writer continues with a presentation of his own theories, which represent an interpretation of the phenomenon by consideration of the factors of interception of the droplets rather than sublimation. *N.A.C.A. T.M. No. 1027*, August, 1942, 11 pages, 2 illus.

The Icing of Aircraft. M. Robitzsch. In this article, which is a translation from *Beiträge zur Physik der freien Atmosphäre*, Vol. 18, No. 4, 1932, factors involved in the icing of aircraft are analyzed from a theoretic standpoint. It is pointed out that a study of the processes accompanying the formation of ice on solid bodies will cover all factors involved and thus make it possible to weigh the effect of each against the total effect. The problem is treated from the beginning, each factor being investigated in logical order. The sublimation formula is interpreted and a method is presented for estimating vapor pressure difference. Varying conditions of saturation of the air with water vapor and changes of temperature are considered. *N.A.C.A. T.M. No. 1028*, September, 1942, 9 pages, 1 illus.

The Navier-Stokes Stress Principle for Viscous Fluids. Ernst Mohr. A translation from *Luftfahrtforschung*, Vol. 18, No. 9, Sept. 20, 1941, entitled: "Uber den Navier-Stokeschen Spannungsansatz für zähe Flüssigkeitsstromungen." The Navier-Stokes stress principle is checked in the light of Maxwell's mechanism of friction and the possibility of another theorem is indicated. According to Maxwell's discovery of the physical mechanism by which shear inflow direction is developed, this shear is only "fictitious" since it merely represents the substitute for a certain transport on macroscopic motion quantity, as conditioned by Brown's molecular motion and the diffusion, respectively. This mechanism is not bound to the special case of the one-dimensional flows but holds for any flow as expression of the diffusion, by which a fluid differs sharply from a plastic body. If it is remembered, on the other hand, that the cause of the stresses on the plastic body lies in a certain cohesion of the molecules, it appears by no means self-evident that this difference in the mechanism of friction between fluid and plastic body should not prevail in the stress principle as well, although it certainly is desirable in any case, at least subsequently, to establish the general theorem in the sense of Maxwell. Actually, a different theorem is suggested which, in contrast to that by Navier-Stokes, has the form of an unsymmetric matrix. Without anticipating a final decision several reasons are advanced by way of a special flow which seems to affirm this new theorem. *N.A.C.A. T.M. No. 1029*, September, 1942, 13 pages, 9 illus.

Civil Aeronautics Administration

Numerous new devices are being developed by the Civil Aeronautics Administration's Technical Development Division. One of these is the seadrome day marker, a product of the Airport Development Section.

The markers are floated on a rubber "doughnut" similar to those used for seadrome night markers, and they carry distinctive symbols on standards 6 to 9 ft. above the water. These symbols, one a circle and the other a triangle, give the pilot a silhouette from all angles. The "doughnuts" are anchored in such a way that the wind and tide do not tilt them very far from the vertical. The symbols are made of plywood, rubber covered, and have small reflectors inserted for emergency use at night. Provisions are also made for installing lights, and a further development involves equipment for turning them on and off by radio to prevent their being of use to an enemy at night.

The C.A.A.'s new ultra-high-frequency, two-course radio range, which combines simultaneous voice communication and sector identification, has been pushed forward to the actual installation stage. Voice communications are superimposed on the range signals, and the pilot uses a visual indicator to follow his course.

Experiments to produce an airplane windshield that can be effectively deiced and strong enough to withstand the impact of heavy birds in flight are under way, and such a wind shield is said to be nearly ready for use.

Training planes now turning out pilots will benefit from a simple and highly effective stall warning device developed by the C.A.A. to prevent the most common of accidents during training.

Simple and less expensive radio fan marker monitors have been developed and are ready for installation throughout the airways systems. These consist of simple receivers placed halfway between the marker and the airport which give a continuous signal when the fan marker is operating properly. If it fails, a siren signal is set off in the airport and a repair man is dispatched at once to the fan marker site to put it in operation again.

Inaccessible radio facilities and remote weather and traffic control posts are now under control of C.A.A. men in the field through the use of radio teletype circuits and controls operated on a frequency modulation system. Remote range stations on mountains and islands, valuable to this nation's airmen, but dangerous if an enemy is able to use them, are turned on and off by remote control. New obstruction markers for warning pilots of the

presence of high towers or buildings are in operation, developed for this purpose by the C.A.A. These are small radio transmitters which give the pilot a distinctive signal in his earphones and in lights on his dashboard, warning him to avoid collision.

An automatic radio-range monitor is now under development which not only warns the C.A.A. airways workers when a radio range gets as much as three degrees off its proper setting but also sends a distinctive aural warning to the pilot that the range is not on proper bearing.

A number of new chemical combinations are now under study for speeding up the work of preparing usable landing surfaces. Six such projects have been requested specifically of the C.A.A. by the War Department. New position markers for planes, particularly taillights which flash and cannot be confused with the light of stars, are now under service test. Following its development of fire extinguishers for airplane engines, the C.A.A. is proceeding with a study of fire extinguishers for use in baggage and freight compartments of airplanes.

Proposed Electrical Installations. The Aircraft Engineering Division has compiled, for the information and guidance of the industry in making electrical installations in aircraft, Proposed Civil Air Regulations Section 04.57 and Civil Aeronautics Manual Section 04.57 pertaining to electrical equipment and installations. The material is issued in two sections consisting of the final draft of the regulation with proposed revisions to the pertinent sections of Part 04, and manual material covering proposed CAR Section 04.57.

The comments that were received on the original drafts attached to Safety Regulation Release No. 76 have been incorporated in this final material. However, since there has been no change in general policy regarding electrical requirements, the proposed future revisions to the regulations are the same in substance, though not as detailed, as those that were a part of Safety Regulation No. 76. These proposed revised regulations have no legal standing at the present time. After the present emergency is over, it is contemplated to present CAR Section 04.57 to the Civil Aeronautics Board for promulgation. *Safety Regulation Release No. 126*, September 3, 1942.

Air-Carrier First-Aid Equipment. The Air Carrier, General Inspection, and Aviation Medical divisions have issued a release on first-aid equipment for air-carrier aircraft. The equipment listed will meet the minimum requirements for first-aid kits prescribed in Amendment No. 122, Part 61, Civil Air Regulations, dated October 1, 1942. Four kits are specified and the contents are tabulated. *Safety Regulation Release No. 128*, September 28, 1942.

Air-Carrier Operation Statistics. Statistics are presented in tabulated form on air-carrier operations. One table covers the six-month periods of July–December, 1941, and July–December, 1940, also the calendar years 1941 and 1940. Another table presents similar statistics for each commercial air line for the year 1941. *Civil Aeronautics Journal*, September 15, 1942.

British Information Services

Under the title "As Hitler Sowed So Shall Hitler Reap," a booklet of 18 pages presents in graphic form statistics covering the retaliatory measures dealt by the British air forces to Germany. Figures and pictures show the tonnage of bombs dropped on German cities and the damage they wrought by comparison with the aerial onslaughts on Britain. Charts indicate the relative intensity of German and British air raids, the proportion of attacks on different types of objectives and the burden imposed on German man power in meeting British air assaults.

Britain's Rise to Air Supremacy. A step-by-step pictorial analysis of Britain's rise to supremacy in the air after the collapse of France in June, 1940, presented in the form of 32 sketches and captions. *Bulletins from Britain*, September 16, 1942.

Air Gunners on the Mark. An Air Correspondent. Several devices used by the Royal Air Force for the training of aerial gunners are described briefly. One is a moving mirror that reflects the image of a scale model airplane in such a way as to simulate the approach and movements of an enemy fighter. Another utilizes beams of light, aimed like a gun, to intercept other beams representing moving targets. A third projects shadows of accurate scale models of aircraft to develop ability in airplane recognition. *Bulletins from Britain*, September 30, 1942.

Books reviewed in this section may be borrowed without charge from The Paul Kollsman Library, Institute of the Aeronautical Sciences, 1505 RCA Building West, 30 Rockefeller Plaza, New York, N. Y.

Military History

Interwoven into this general history of the military program is the account of the pathetically inadequate attention given to the airplane as a weapon of war. Until the present war it was so inconsequential that only a few references had to be made to this branch of the service. The author follows the growth of the Army chronologically from 1776 to Bataan. It is a book useful primarily for the professional soldier but contains a wealth of reference to all military development.

The History of the United States Army, by William Addleman Ganoe; D. Appleton-Century Company, Inc., New York, 1942; 640 pages, $5.00.

Defense Materials

There is no person in the United States who has not felt the pinch of the lack of some strategic material. The lack of rubber, tin and silk is perhaps felt the most by individuals, but the manufacturer at almost every turn is met with a shortage of metals as well as other essential materials. Until the extent of this deficiency in our war supplies is brought home to the public, there will still be grumbling. The book lays out a jig saw puzzle of materials which, when assembled, makes a discouraging picture for the lay reader. It covers the principal strategic materials, gives a short story of their background and production, and then presents the sad news of their shortage. It is not a cheerful future that is presented but one that everyone should understand so that when the time comes for a further curtailment of personal requirements the necessity for the action will be accepted with understanding instead of confusion.

Strategic Material in Hemisphere Defense, by M. S. Hessel, W. J. Murphy, and F. A. Hessel; Hasting House, New York, 1942; 235 pages, $2.50.

New War Tactics

It has been stated by many experts that this book is the most important book on military tactics which has been published since the War started. Although the book deals principally with the employment of infantry, artillery and tanks, the stress that is put upon air forces is emphatic. Using the Spanish War as an experimental field the author traces many of the German Blitzkrieg tactics to the experience gained there. He believes "it is the combination of these three factors—motorization as a method of transport, mechanization as a method of break-through, air action as a method of support, protection and communication—that gives the warfare of today a character entirely different from that of the last World War."

The new methods of infiltration along a narrow front and the follow-through with a speed never before known, with a rolling-out in many directions from the tank columns which have penetrated a front, are the fundamental new conceptions of attack.

The air arm becomes the hammer of modern warfare on land. Mastery of the air or air superiority are the new concepts of modern battles. These are exemplified by many instances and the functions of each type of combat aircraft are described as they are used in the blitzkrieg.

The differences in military concepts of the French and German staffs are emphasized and the dominating influence of weather on air operations indicates that attacks now must be made during fair weather.

To sum up the author's contentions, the internal-combustion engine has brought a revolution in warfare. Used in combat it has different functions from its use in economic warfare or long-range bombing of industrial centers. While these have a military value, success in battle is usually decisive. The revolutionary methods of using the air arm that is advocated will, it is claimed, make or break nations.

The employment of antiaircraft guns is described. The specialized function of artillery in modern battle and the creation of "islands of resistance" give startling new ideas of the new tactical disposition of troops. The author was a Czechoslovakian officer who fought in Spain and is now serving in England. His main theme is that the principle of attack is always successful and, unless other armies adopt new methods and tactics, that they cannot overcome an enemy who is experienced in their "blitz" principles.

Attack: A Study of Blitzkrieg Tactics, by Major F. O. Miksche; Random House, New York, 1942; 267 pages, $2.50.

A Lasting Tribute

The Daniel Guggenheim Fund for the Promotion of Aeronautics engaged in so many diversified activities that it is fortunate that so able an author as Mr. Cleveland has written a book that describes the work of this great benefaction as well as its results. Starting with a gift of $500,000 to establish a school of aeronautics at New York University the Fund was augmented by further contributions of over $3,000,000. The wide range of uses to which this fund was put is described in detail. Education, meteorology, air transport, blind flying, safety, The Daniel Guggenheim Medal, libraries—all were within the purview of the directors of the great fund. It has taken almost a score of years for the results of the Fund's work to be realized in later developments. The book will be a lasting tribute to the foresight of the donor of the Fund as well as to his son, Harry Guggenheim, who directed its program. Fortunately, the gift of Mrs. Guggenheim of the Estate on Long Island in memory of her husband and the Minta Martin Endowment Fund for its upkeep were announced before the book went to press and an epilogue describes this fitting aftermath of the living work of the Fund.

America Fledges Wings, by Reginald M. Cleveland; Pitman Publishing Corporation, New York, 1942; 224 pages.

The Patrol Torpedo Boats

This epic account of the heroic work done by Motor Torpedo Boat Squadron 3 in the Philippines will always be one of the great stories of the war. While it is primarily about motor torpedo

boats, it gives a pathetic picture of the annihilation of the air forces that were stationed around Manila and, by inference, shows what a different result might have been achieved had there been adequate air forces. The thrilling account of how General MacArthur was taken from Corregidor to the island of Mindanao by motor boat and from there by air to Australia will always form a part of war history. The lack of air transport to remove officers facing capture by the Japanese is one of the tragedies of our war preparation.

They Were Expendable, by W. L. White; Harcourt, Brace and Company, New York, 1942; 205 pages, $2.00.

For Civilian Pilots

Stripped of nonessential mathematics and technical language, this book is designed to give the pilot and instructor the information that every pilot is required to have before he can be regarded as a competent operator of an airplane under C.A.A. regulations.

The elements of flight theory, meteorology, aerial navigation, and the art of radio are outlined. Civil Air Regulations are digested and typical questions on private pilots certificate tests are included. The book will not serve as a useful textbook but, as its title indicates, a handbook for reference for pilots who wish to refresh their memories and keep informed of the current regulations.

Private Pilot's Handbook, by A. G. Norwood; Pitman Publishing Corporation, New York, 1942; 258 pages, $2.50.

Naval Aviation History

Five years ago when the first edition of this book appeared it was accepted as a definitive history of naval aviation. The author, a pilot, spent many years preparing a chronology of air activities of the Navy and, using this as a basic reference, wrote what is undoubtedly the only thoroughly comprehensive account of the development of the air arm of the Navy. Bringing this record up to July of this year and with revisions necessitated by recent events, the book tells the story of the origin and development of naval aviation from its experimental beginnings to its present-day complexity and efficiency.

No one can read this recounting of the obstacles that the early navy pilots had to overcome without a realization of the low regard the airplane received when it first appeared. The determination of the first head of naval aviation, Capt. Irving Chambers, was thwarted so many times that only by that dogged persistence for which sailormen are noted was he able to make even slow headway.

The huge expansion of the Navy, particularly in the training of pilots, makes it opportune to have available an up-to-date history of flying as applied to naval strategy and tactics.

Navy Wings, by Lt. Comdr. Harold Blaine Miller; Dodd, Mead & Co., New York, 1942; 364 pages, $3.00.

Coast Guard Service

Only when the Coast Guard makes a rescue or sinks a submarine is the public reminded of the constant routine patrol of this gallant service. This book gives the details of the work of the Coast Guard in the form of the story of a graduate of Pensacola Naval Training school for pilots who reported for duty at Floyd Bennett Field and joined the group of Coast Guard pilots who patrol the New York area. The story of Ens. Jim Brewster gives a vivid picture of the many varied duties of the Coast Guard in rescuing sailors and in the latter chapters, searching for submarines and sinking them occasionally. By following the interesting life of Brewster the reader secures an insight into the important work done by this branch of the Navy.

Air Patrol, by Henry B. Lent; The Macmillan Company, New York, 1942; 170 pages, $2.00.

Sheet Metal Repair

This text is concerned chiefly with methods and processes for the repair of sheet metal parts used in aircraft construction. Although some manufacturing operations are included, they are usually of the kind that can also be used for repair work.

The instruction presented is not too elementary for the experienced metal worker or too involved for the mechanically inclined neophyte. It is based almost entirely on actual jobs. Illustrations are used freely.

Some of the section headings are: aircraft structure; aircraft sheet metal work; cutting machines; hand tools for cutting and punching; seams and joints; machines for bending and forming; and metal spinning. Others deal with reinforcing and stiffening; hand tools for forming; bumping and raising; metals used in aircraft construction; screwed and riveted joints; and soldering. Also offered for study are: welding in aircraft repairs; repairs on skin covers; repairs on tanks, floats and cowling; repair of structural members; aircraft bumping; cooling and oiling systems.

Aircraft Sheet Metal Construction and Repairs, by M. P. Harrold; Frederick J. Drake & Co., Chicago, 1942; 158 pages, $1.50.

Text on Blueprint Reading

A text is presented to assist workers in metal trades to understand blueprints. The course consists of a series of related steps designed to give students an understanding of shop blueprints without necessarily teaching them to make mechanical drawings. The mechanical drawings which are used deal with those parts most frequently encountered in industry. Problems are changed from job to job to enable the student to apply the information taught with each job. The problems presented vary in difficulty, as they would in the shop, but the aim of the author has been to make all problems practical and of the type found in industry. Questions are given to help the student in an understanding of the relation of the blueprint to the part. The book also is intended to be valuable for reference purposes.

Blueprint Reading at Work, by William W. Rogers and Paul L. Welton; Silver Burdett Company, New York, 1942; 136 pages, $1.28.

Text on Shop Mathematics

The book presents the mathematics most commonly included in courses in shop mathematics. It is designed to function as a single source of instruc-

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tion to replace the reference book plus work sheet type of instructional material. The problems given represent real shop situations in a variety of trades, and the terminology of the shop is used throughout the text. The problems have been graded with the object of giving the student a real understanding of each unit. Special attention has been given to the statement of problems. In general, the facts or data are given at the outset, then the question asked is based on these data. This method of presentation is used to cause the student to recall and use the data previously given. Sections of the book cover common and decimal fractions, measurement, using letters and numbers, equations, exponents and square roots, formulas, ratio and proportion, geometric constructions, and right triangle trigonometry.

Shop Mathematics at Work, by Paul Welton and William W. Rogers; Silver Burdett Company, New York, 1942; 204 pages, $1.56.

Aviation Physics Text

As this textbook was written by naval officers on duty at Annapolis for the use in the instruction of students, it has the advantage of being clear, concise and thorough. It supplements the regular physics textbook by giving emphasis to the theory of flight, as the author believes that elementary aerodynamics is a part of applied physics and not a separate subject. For a student who wants to study the fundamentals of aerodynamics, this book will provide the essential requirements.

The Physics of Aviation: An Elementary Text on the Theory of Flight; prepared for the Department of Electrical Engineering, U.S. Naval Academy, Annapolis, Md., 1942; 124 pages, $1.15.

Aviation Primer

A primer for the use of beginners in flying, this elementary book will serve to acquaint boys and girls with the rudiments of aviation. Written in conversational language it gives the principles, as well as the practical sides, of flight in words that are understandable to the youngest student.

Junior Aviation Science, by D. H. Grimm; Noble and Noble, Publishers, Inc., New York, 1942; 112 pages, $0.90.

Aerial Navigation

In this as in several other new books, aerial navigation is joined with another related field. In this case it is with map reading, a logical choice. The reading of maps has become such an essential part of any pilot's requirements that such an authoritative study will be most useful at this time. The methods and cameras used in aerial photography are described in detail, and practically every relationship between the aerial photograph and the making of contour maps is shown with numerous illustrations. Special districts are given intensive study so that a pilot will have a comparative idea of oblique and vertical views and contour views and maps of the same areas.

The second half of the book is devoted to avigation. The use of the Air Almanac and the instruments used in air navigation are described and problems which the pilot has to solve are illustrated.

An appendix gives excerpts from the Air Almanac and a vocabulary.

Map Reading and Avigation, by Richard M. Field and Harlan T. Stetson; D. Van Nostrand Company, Inc., New York, 1942; 129 pages, $2.50.

Army Organization

This book, by its emphasis on the work of the Army Air Forces, shows the increasingly important part flying is playing in the nation's military arm. The author has visited many camps and writes from first-hand knowledge. Every type of camp and every branch of the service is shown in the making. Primary, basic, and advanced flying schools are described. The training of mechanics and paratroops is also followed. The book gives a compact picture of America's new Army in the making.

Our New Army, by Marshall Andrews; Little, Brown and Company, Boston, 1942; 225 pages, $1.50.

Aircraft Models

Information is presented on how to build scale model airplanes that will fly. Illustrations and many drawings of both the planes and operating mechanism are furnished. The reader is given an outline of aerodynamics. Gear boxes, directional control, wing fixing, landing gears, and airscrews are discussed. Other sections cover finishing, flying, and photographic models.

Scale Model Aircraft That Fly, by H. J. Towner and Howard Boys; The Harborough Publishing Company Limited, Leicester, England, 1942; 96 pages, 3*s.* 6*d.*

Juniors in Air Defense

A book for boys who can and are assisting in air-raid precautions. It relates a story of the work of wardens in a small city where conflicting currents of Americanism and foreign descent cross and lead to accusations that give young readers a thrill. Spies, shipwrecked sailors, night-riding white-robed groups bent on hanging traitors, sabotage and other current occurrences give the author an opportunity to provide interest for youthful readers.

Junior Air Raid Wardens, by Jack Bechdolt; J. B. Lippincott Company, New York, 1942; 175 pages, $1.75.

War Criticism

A commentator on the current events of the war reviews the first six months of operations from the point of view of a severe critic of almost every military and naval action. His principal theme is for offensive action against Japan by way of the Aleutian Islands. The top ranking officers of the Army and Navy, as well as the overstaffed bureaus and boards, are castigated with vehemence and frankness.

The deficiencies, as well as the victories, of air operations receive criticism and praise but the author is convinced that success must come eventually by destruction of Japanese industry through air power.

Blueprint for Victory, by Homer Brett; D. Appleton-Century Co., New York, 1942; 215 pages, $1.75.

Elements of Navigation

The R.A.F. motto says, in Latin, that the way to the stars is arduous. The author, a professor of geography at the University of Cambridge, claims that these difficulties can be reduced if one starts young enough and travels by easy stages. His chapters follow the plan of introducing the student to the elements and instruments of navigating by the stars. As the book is the result of teaching cadet airmen, it is limited to the rudiments of the science with a minimum of mathematics and a maximum of common sense. As the graphic method is used, a picture of what is being done, as well as the answer, is given.

Astrographics, by Frank Debenham; Chemical Publishing Company, Inc., Brooklyn, N.Y., 1942; 118 pages, $2.75.

Anecdotes on Flight

The author makes no claims of completeness in the sketchy account of the beginnings of man's conquest of the air. He prefers to term it an "anecdotage, a miscellany." His method is to quote excerpts from contemporary writers, dreamers and inventors. The

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The Pacific Aeronautical Library
6715 Hollywood Boulevard
Hollywood, California

Established in cooperation with the aircraft companies the library serves. The leading aircraft companies in or near Los Angeles participate in its support and operation.

This service library for aeronautical research is available to the public for reading privileges. Source material includes aerodynamic and structural research reports, as well as books on drafting, production methods, history, and allied sciences. It furnishes books, periodicals, and pamphlet material to the participating aircraft companies to supplement their engineering libraries.

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quotations start in mythologic times and continue to the present. For those who enjoy the curious style of early writers on aeronautics the book will provide a convenient and short anthology. The author links together the excerpts into a narrative that, while covering too great a field in too few pages, will give to those who do not care to go to original sources an interesting glimpse of the origins of flight.

The Birth of Flight, by Hartley Kemball Cook; W. W. Norton & Company, Inc., New York, 1942; 204 pages, $2.50.

Brazilian Air Journey

The author, accompanied by an accomplished woman companion photographer, flew 15,000 miles over Brazil, and this book is the story of the flight. With official sanction and assistance they visited many of the 512 airports of Brazil. The author's observations of the country and its people give an intimate picture of the life and customs of this strategically located republic. An experienced observer of aviation progress, having been chief of Public Information for the C.A.A., Mrs. Hager has written not only an interesting adventure story but in an appendix has given a summary of Brazilian aviation both military and civil. The illustrations are excellent and will give the reader a graphic picture of Brazil which is now bound so closely to the United States in the war effort.

Frontier by Air, by Alice Rogers Hager; The Macmillan Company, New York, 1942; 243 pages, $3.50.

Spanish-English Technical Dictionary

At this time when there is such growing intercourse between the technicians of the United States and Central and South America, a new English-Spanish dictionary will prove to be more useful. Over 45,000 words are translated and the newer fields of aeronautics, plastics and meteorology are given special attention. A useful appendix gives conversion tables of weights, measures and money.

Nuevo Diccionario Tecnico—Commercial; Editorial Tecnica Unida, Brooklyn, N.Y., 1942; 600 pages, $10.

Pilot Training Text

This book is a revision of the author's Air Pilot Training and constitutes the first volume of a two-volume edition of the enlarged work. It contains all the subject matter needed for preparing for the written examinations for a private and commercial pilot's certificate with the exception of the Civil Air Regulations. It was written by a pilot for pilots.

The book is written without mathematical formulas and therefore is readily grasped by those who do not have the training for advanced presentation. The chapters on aircraft engines are also written in such a way that they may be easily understood by the beginner pilot.

It is a comprehensive book well adapted for the use of the thousands of new pilots who are now in training.

Theory of Flight and Aircraft Engines, by Bert A. Shields; McGraw-Hill Book Company, Inc., New York, 1942; 377 pages, $2.75.

Aviation Mathematics

Applications of the fundamentals of mathematics to the field of aeronautics are covered in this book. It is offered as a practical presentation of the subject and opens with a review of elementary arithmetic. The second chapter deals with the simple algebraic equation, which is the foundation for evaluating formulas, the subject taken up in the next chapter. Following chapters deal with the reading and plotting of graphs, ratios, proportions, and percentage; the right triangle; and geometric constructions. In the final chapter a few of the more simple applications in mechanics are covered. The remaining pages contain answers to problems and tables of logarithms and trigonometric functions.

Practical Mathematics of Aviation, by A. E. Downer; Pitman Publishing Corporation, New York, 1942; 120 pages, $1.00.

Aircraft Recognition Data

The second issue of this guide, published quarterly, includes a number of new airplanes as well as later models of the aircraft that appeared in the earlier issue. It contains information on 90 of the leading fighting airplane types of the United States, Great Britain, Norway, Germany, France, Russia, Japan, and Italy.

A full page is devoted to each type of airplane, uniformly made up to present a photograph of the plane, its type designation, wing and tail markings, description, recognition characteristics, specifications and three-view silhouettes. Although dated April 15, 1942, the periodical has been recently issued.

Aeronautics Aircraft Spotters' Guide, Issue Number 2, edited by Harold E. Hartney; National Aeronautics Council, Inc., New York, 1942; 96 pages, $0.25.

Varied Experiences

The author, who is one of the best known among foreign correspondents, uses his leisure time during the 20 days of voyaging with a convoy from Halifax to Liverpool recalling incidents of his remarkable career. He tells of prize fighters, oysters and whiskey, Lord Beaverbrooke, gamblers, caterers, dueling and baseball, but the two chapters that will have the greatest interest for aviation people are those in which he gives an intimate close-up of Bishop, the Canadian Ace, and of his experiences during a flight to the Bahamas and back with a pilot who was bootlegging.

Convoy, by Quentin Reynolds; Random House, New York, 1942; 303 pages, $2.00.

Pictorial Story of Aircraft

The principal reason for the attraction of this book is in the illustrations, some of which are in color. The author has written the text to explain the pictorial sequences. The photographs were carefully selected so that they give the reader a fairly comprehensive idea of the development of the airplane and airship. A short description of how an airplane flies and a brief outline of some of the world's airways is added to the description of types of aircraft. As a gift book it will serve a useful purpose.

The Book About Aircraft; Frederick Warne & Co., Ltd., London, 1942; 108 pages, 7*s.* 6*d.*

Aeronautical Personalities

At a most opportune time, this biographic record of the leaders in American aviation becomes available. Over 4,000 names are listed with short sketches. Emphasis is given to the aeronautical activities of each person. The data were compiled by The Writers' Program of the W.P.A., cosponsored by the Illinois Aeronautics Commission and the Chicago Aero Commission.

This book and the bibliographies of aeronautics published by the Institute are excellent results of the W.P.A. program and will be valuable additions to aeronautical libraries. This book will be particularly useful as a standard reference and should be within arm's reach of anyone engaged in the aeronautical field.

Who's Who in Aviation, compiled by The Writers' Program of the Works Project Administration; Ziff-Davis Publishing Company, New York, 1942; 486 pages, $5.00.

Book Notes

Descriptive Geometry, by Ferdinand A. P. Fischer and James A. Clear; The Bruce Publishing Company, Milwaukee, 1942; 244 pages, $3.00.

A textbook on descriptive geometry. The descriptive matter is divided into five stages: a discussion of the fundamental principles underlying the problem under consideration; the data "given"; what is "required"; analysis of the data; the method of solution. Utilizing the various methods of solution, problems are solved either by the Auxiliary Plane Method, the Oblique Plane Method, or the Direct Method, with suggestions as to which is best suited for a particular type of problem. To the text is appended a series of prepared problems, a set of supplementary problems, and a group of unit tests.

Airfoil Sections, by R. H. Warring; The Harborough Publishing Company Ltd., Leicester, England, 1942; 59 pages, 2*s*.

This is a revised version of an original volume on airfoil sections by J. W. B. Cruickshank. It contains data on a large number of airfoil sections which should be particularly useful to builders of airplane models. For assistance in choosing the type of section and in making calculations on performance, an elementary working knowledge of airfoil theory is covered in its opening chapters.

ABC of the RAF, edited by Sir John Hammerton; The Amalgamated Press Limited, London, 1942; 160 pages, 2*s*. 6*d*.

A handbook of information on the various departments of the British Air Forces. The first section treats of the purposes, functions, and composition of the Royal Air Force. The second section discusses the elements of flying. The third section is devoted to a study of special training and equipment in the R.A.F. and its fourth to the elements of air fighting. Reflecting the administrative changes and technical advances that have taken place in the Royal Air Force since the initial appearance of this book in June, 1941, this is a second and enlarged edition.

Civil Defense Measures for the Protection of Children, by Martha M. Eliot; Bureau Publication No. 279, United States Department of Labor, Washington, 1942; 186 pages, $0.30.

A report of observations in Great Britain during February, 1941, on services for children, including those connected with evacuation. The author was at the time a member of the United States Civil Defense Mission to Great Britain. In addition to the record of observations, the report comprises summaries of official memorandums, comments, and a series of recommendations on measures for the protection and welfare of children in a civil defense program in the United States.

The Air Cadets' Handbook on Navigation, Parts One and Two, by W. J. D. Allan; George Allen & Unwin Ltd., London, 1942; Part One, 79 pages, 2*s*.; Part Two, 80 pages, 2*s*.

These two handbooks present a study of air navigation and its problems. The text is illustrated and examples of each topic are given. Among the subjects covered are plotting, the reporting of positions, the use of maps, and the use of compasses and other instruments. Part I includes a section on signaling.

Aircraft Engine Trouble Shooting Chart, arranged by Andrew Wallace; The Norman W. Henley Publishing Co., New York, 1942; $0.75.

This is a reference chart for tracing engine troubles and finding out the proper way to correct them. Through the medium of a "Sound Section" on the chart, troubles are diagnosed. These in turn are identified by smaller sections arranged around the Sound Section. All the sections are connected by guide lines with advice on the proper procedure for the correction of each difficulty.

The Ships and Aircraft of the U.S. Fleet, by James C. Fahey; Ships and Aircraft, New York, 1942; 64 pages, $1.00.

Based on officially released government documents and matter appearing in the public prints, data are listed on the ships and aircraft comprising the United States Navy in its wartime form. Included are photographs, dimensions, specifications, descriptions, etc. The information is separated into sections on United States Naval vessels, United States Naval Aircraft, fleet auxiliaries, and United States Coast Guard craft.

Spitfire Pilot, by Flight Lt. D. M. Crook; Faber and Faber Limited, London, 1942; 104 pages, 5*s*.

A narrative describing the author's experiences as a Spitfire pilot with the British 609 Squadron. Covering the period from August, 1939, to November, 1940, the incidents related are first-hand accounts of happenings at Dunkirk and throughout the Battle of Britain.

Global War, by Edgar Ansel Mowrer and Marthe Rajchman; William Morrow and Company, New York, 1942; 128 pages, $1.00.

This is an atlas of world strategy. The basic maps serve to illustrate an interpretation of each country's strategic position as to sea, land and air communications. They also depict natural resources and geographic factors. Divided into four separate sections, the atlas analyzes world communications, natural routes of invasion, some characteristics of the great powers in 1939, and the revolution in warfare.

First Stage Mathematics Suitable for the R.A.F. and A.T.C., by A. F. Buchan and R. Borthwick; University of London Press, Ltd., Bickley, Kent, England, 1942; 126 pages, 2*s*. 3*d*.

School mathematics are reviewed for the specific use of men who require a refresher course for joining the Royal Air Force or the Air Training Command. The essentials of each subject are outlined without developing them according to strictly orthodox mathematical procedure. The book includes study of arithmetic, algebra, geometry, logarithms, and trigonometry. Other subjects covered are graphs, the compass, and the triangle of velocities. Supplementary examples and test questions are also given.

Things to Make; Rolls House Publishing Co., Ltd., London, 1942; 64 pages, 6*d*.

Second edition of a booklet describing how air-training equipment can be made from scrap material. Directions and diagrams are by instructors of the British Air Training Corps.

Leonardo: Master of the Renaissance, by Elisabeth Hubbard Lansing; Thomas Y. Crowell Company, New York, 1942; 237 pages, $2.75.

Although the cover and one of the illustrations show Leonardo da Vinci working on his flapping-wing flying machine, his work in the aeronautical field is scarcely mentioned. The book recreates the Italian world he lived in and gives the reader an acquaintance with the painter rather than the scientific investigator.

War Volume of Compton's Pictured Encyclopedia; F. E. Compton & Company, Chicago, 1942; 134 pages, $1.50.

This is an alphabetical reference book on the present war. Persons, places and events are listed, as well as armies, navies, air forces, and economic resources. The encyclopedia also includes information on weapons, tactics, and strategy.

Marine Engineering, Volume I, Herbert Lee Seward, Editor; The Society of Naval Architects and Marine Engineers, New York, 1942; 353 pages, $6.00.

The work of several authors, this is a detailed survey of marine engineering. On the assumption that the reader is reasonably familiar with the underlying scientific principles, the basic subjects of thermodynamics, practical and applied mechanics, machine design, etc., are omitted but are referred to occasionally. The book covers propelling machinery, power and revolutions, procedure in general design, boilers, and reciprocating steam engines. Other topics it deals with are: steam turbines, Diesel engines, reduction gears, propellers and shafting, materials and metallurgic engineering.

Aircraft Riveting Fundamentals, by George E. Tabraham; The Bruce Publishing Company, Milwaukee, 1942; 31 pages, $0.50.

Preceded by basic information about aircraft riveting, exercises are given on ten primary riveting jobs. Each exercise is planned according to the following topics: reasons for job, materials, tools, safety, procedure, references, and questions. A diagram accompanies each job example.

Studies of Visual Fatigue, by Ross A. McFarland, Alfred H. Holway, and Leo M. Hurvich; Graduate School of Business Administration, Harvard University, Soldiers Field, Boston, Mass., 1942; 255 pages, $3.00.

These are the published results of investigation into eyestrain causes initiated by the Committee on Scientific Aids to Learning carried out by Tufts College, Harvard Psycho-Educational Clinic, and the Graduate School of Business Administration, Harvard University. After an introduction to the subject, the book considers reading and the visual near-point, reading distance and the size of the pupillary aperture, and ordinary blinking and visual fatigue. It also covers the relaxed blink and visual fatigue; reading, eye movements and exercise; perceptual factors and visual fatigue; and physiologic variables and visual fatigue.

Diesel Maintenance, by T. H. Parkinson; Iliffe & Sons Ltd., London, 1942; 196 pages, 6*s*.

Presenting information on the servicing of the modern transport Diesel, this book was developed from certain articles appearing in the magazine *Bus & Coach*. It is intended to furnish the reader with a knowledge of Diesel engine maintenance that would take several years of ordinary workshop experience to acquire. Special attention is given to the subject of fuel pump repairs. Opening pages review the history of the transport Diesel. Following chapters cover the planning of repair schedules, engine maintenance, injection equipment, the adjustment and alignment of engine auxiliaries, bench and road testing, the selection of spare parts, the layout of the garage and workshop, and the future of the oil engine. A chapter in the nature of an appendix deals with useful information concerning individual makes of engines.

U.S. Naval Academy; compiled by workers of the Writers' Program of the Work Projects Administration in the State of Maryland; The Devin-Adair Company, New York, 1942; 158 pages, $2.00.

A short history of the naval school and short sketches of the men who created it and made it famous.

Because of These, by Anthony Richardson; Hodder & Stoughton Limited, London, 1942; 61 pages, 23*s*. 6*d*.

Out of every war comes inspirational verse. The writer seems to catch some ideal, sorrow or vision which only poetry can express. The poems in this little book have the merit of being written by a Flight Lieutenant who is close enough to the tragedies of the R.A.F. to put them in words that leave impressions that cannot be interpreted in prose.

How Every Boy Can Prepare for Aviation Service, by Keith Ayling; Garden City Publishing Company, Inc., New York, 1942; 125 pages, $0.50.

Intended primarily for young men trying to find the proper places for themselves in military aviation, this handbook outlines various jobs in the air forces. It contains information on how they can condition themselves in advance to become pilots, bombardiers, gunners, mechanics, ground officers, etc.

Aeroplanes and How They Fly; Longmans, Green and Co., London, 1942; 44 pages, 1*s*.

An introductory booklet on aeronautical theory. It contains no mathematical formulas and is well illustrated.

New World Horizons, edited by Chester H. Lawrence; Duell, Sloan and Pearce, New York, 1942; 92 pages, $2.75.

This geography is based upon a concept of the world from the point of view of an aeronautical age, with actual linear miles replaced by the measurement of distance in terms of the time it takes to cover it. Governed by consideration of the fact that the earth has shrunk in terms of travel, transportation and communication, this text offers a geographic basis for the study of current events. An extensive collection of maps, charts, and photographs is included.

Poisson's Exponential Binomial Limit, by E. C. Molina; D. Van Nostrand Company, Inc., New York, 1942; 47 pages, $2.75.

A presentation of the tables involved in Poisson's Exponential Binomial Limit, used by the Bell Telephone System for the solution of telephone trunking problems. These are said to be basic to techniques for inspection and sampling data. Table I contains individual terms and Table II covers cumulated terms.

Aircraft Mechanic's Pocket Manual, by Joseph A. Ashkouti; Pitman Publishing Corporation, New York, 1942; $1.50.

Offered in revised form, this pocket manual contains basic data for both the man in the shop and the airplane manufacturer. Available data on Army, Navy and commercial aircraft-design recommendations are presented. The information has been prepared to explain why various methods, processes, and finishes are used in aircraft construction. The first part of the manual deals with aircraft identification standards, layout methods, shop arithmetic, flat pattern layout, and materials of construction. Following sections cover standard aircraft finishes, Army-Navy standard parts, screw pipe threads, drilled and reamed holes, tools, and aircraft nomenclature.

Civilian Protection; Washington State Defense Council, Seattle, Washington, 1942; 60 pages.

This handbook provides air-raid protection information for civilian volunteers. Sections cover air-raid precautions, what to do in an air raid, war gases, blackouts, emergency traffic control regulations, school protection, civilian protection, experience of England, and evacuation.

Air Raid Wardens and Every Civilian; Civilian Protection Division, Seattle, Washington, 1942; 47 pages.

Information for air-raid wardens and civilians is furnished in this booklet. Sections cover high explosive bombs, incendiary bombs, war gases, and home protection. The various kinds of bombs and war gases are described in considerable detail. Information on the extinguishing of fire bombs is furnished. Blackout and other air-raid precautionary measures are outlined.

Models of Fighting Planes of the United Nations; The Garden City Publishing Co., Inc., New York, 1942; 27 pages, $1.19.

This is a group of 16 scale models of United Nations airplanes which can be cut out and assembled. Ten of these are actual flying models. The book contains general building and flying hints as well as explanatory instructions.

Training Course for Air Raid Wardens, compiled by W. L. Beuschlein; Civilian Protection Division, Seattle, Washington, 1942; 45 pages.

This booklet covers Class 4, the organization of civilian defense, and Class 5, duties during an air emergency. The material for these classes has been taken from plans and methods of operation developed by the Seattle Air Raid Warden organization. The part of the booklet devoted to Class 4 contains information on the Civilian Protection Division and the Air Raid Warden organization. Sections cover the duties of an air-raid warden preliminary to an air attack, and what an air-raid warden should know. Under Class 5 is covered the warden's duties during an emergency.

Handbook of Special Steels; Allegheny Ludlum Steel Corporation, Pittsburgh, Pa., 1942; 127 pages.

A revised edition of this handbook incorporating information on the various grades of stainless, tool, and other special alloy steels, has been issued. It is adapted for the use of design engineers and production men and includes data for guidance in the proper selection, treatment, and use of these alloy steels. Finder charts and tables facilitate quick reference.

Tool steels are discussed with suggestions for selecting the proper grades. There is appended a table setting forth recommended types for particular applications, and information on drill rod with a list showing sizes, weights and prices. Under a heading "Special Products" the handbook deals with shoe die steel, silchrome valve steels and special shapes. There is also detailed information, engineering tables and other data on Nitralloy steels and stainless steels, with a discussion of the Pluramelt technique, electrical steels, and carbon steels. A large section of the handbook is given over to charts dealing with steel weights and with sizes of flats and numerous other shapes.

Library Accessions

Airplane Descriptions

The Book of the "Spitfire" War Planes; Real Photographs Co., Liverpool, 1941; 19 pages, 1*s.* 3*d.*

The story of Reginald J. Mitchell and the Vickers Supermarine Spitfire, well illustrated with diagrams and photographs.

The Identification of British and Enemy War Planes; Real Photographs Co., Liverpool, 1941; 23 pages, 1*s.* 3*d.*

Details of 24 British, American, German and Italian airplanes.

The Identification of British and American War Planes; Real Photographs Co., Liverpool, 1941; 23 pages, 1*s.* 6*d.*

About 24 British and American airplanes are identified.

Interior Details of War Planes; Real Photographs Co., Liverpool, 1941; 23 pages, 1*s.* 6*d.*

Diagrams, photographs and data on about 24 British and German airplanes.

What Is That Aeroplane? edited by Eric Sargent; Sampson Low, Marston & Co., London, 1941; 58 pages, 4*s.* 6*d.*

A second edition giving data on and three-view profiles of 119 English, American, German and Italian airplanes.

Avigation

Air Navigation; an Introduction to Practical Navigation, by W. J. D. Allan; Sir Isaac Pitman & Sons, London, 1941; 80 pages, 3*s.* 6*d.*

First published in 1939, the revised edition of this book takes into account changes in practice caused by the war.

Practical Air Navigation Simply Explained, by J. K. Summers; Sir Issac Pitman & Sons, London, 1941; 57 pages, 2*s.* 6*d.*

An introductory text in dead-reckoning navigation, requiring only a knowledge of elementary mathematics.

Civilian Defense

La Guerre Aéro-Chimique et les Populations Civiles, by L. Izard, J. des Cilleuls and R. Kermarrec; Charles-Lavauzelle & Cie., Paris, 1932; 243 pages.

An analysis of the problems encountered, and the means to be employed, in the protection of civilian populations against enemy attack with poison gas.

Design and Construction

Aeronautical Sidelights, by Brian Worley; C. Arthur Pearson, London, 1941; 112 pages, 3*s.* 6*d.*

Articles on the protection of military pilots from excessive acceleration during flight, contrarotating propellers, fighter fundamentals, and hydrofoils, reprinted from the British magazine *Aeronautics.*

Proceedings of the World Engineering Congress, Tokyo, 1929; Vol. I, General Reports; Vol. V, Precision Machines and Instruments, Aeronautics and Aeronautical Engineering; Kogakkai, Tokyo, 1931; Vol. I, 248 pages; Vol. V, 632 pages.

This volume includes 22 technical papers on aeronautical engineering, in English, French or German.

Reference Book of Aircraft Wheels, Brakes and Oleo Struts, by David Vine; Sir Isaac Pitman & Sons, London, 1941; 61 pages, 1*s.*

A practical book on the functions of the various parts of the airplane undercarriage, covering British practice.

Fiction

Smithy, by Alexander Smith; Jonathan Cape, London, 1939; 311 pages, 7*s.* 6*d.*

Reissue of a book first published in 1936, dealing autobiographically with the humorous experiences of an air mechanic in the Royal Naval Air Service during the World War, 1914–1918.

Women in the Wind, by Francis Walton; Farrar and Rinehart, New York, 1935; 308 pages.

Events during a transcontinental air race form the basis for this novel.

Flight Instruction

The Air Cadet's Handbook on How an Airplane Flies, by Charles G. Grey; George Allen and Unwin, London, 1941; 86 pages, 2*s.*

An explanation of the elements of aerodynamics, illustrated with numerous line drawings. One of the "Observer's Handbook" series.

Flying from the Ground Up, by R. Sidney Bowen, Jr.; Whittlesey House, McGraw-Hill Book Co., Inc., New York, 1931; 234 pages.

The essential principles of piloting explained in a nontechnical manner.

Ground Instructor Rating; An Auxiliary Text to "Ground Instructor," by Charles A. Zweng; Pan American Navigation Service, Glendale, Calif., 1941; 111 pages, $3.00.

An advanced question-and-answer

text covering the subjects needed for the C.A.A. multiple choice examination: the airplane and aerodynamics, aircraft power plants, air navigation, aeronautical meteorology, and civil air regulations.

How to Fly an Airplane; A Textbook for Beginners, by Percival White; Harper & Brothers, New York, 1930; 358 pages.

Elementary flight instruction, with chapters on primary and advanced maneuvers, and additional material on gliders, seaplanes, parachutes and cross-country navigation.

Materials

Aircraft Processes, by Sydney H. Phillips; Warren F. Lewis, Los Angeles, 1941; 176 pages, $2.50.

A manual on the materials and processes used in the aircraft industry.

The Practical Application of Aluminium Bronze, by C. H. Meigh; McGraw-Hill Book Co., Inc., New York, 1941; 112 pages, $4.00.

A practical treatise on the properties, production and uses of aluminum bronze. The author is a British metallurgical engineer.

Mathematics

Table of Natural Logarithms, Volume I, Mathematical Tables Project; Work Projects Administration, New York, 1941; 501 pages, $2.00.

Logarithms of the integers from 1 to 50,000 to 16 places of decimals.

Table of Natural Logarithms, Volume II, Mathematical Tables Project; Work Projects Administration, New York, 1941; 501 pages, $2.00.

Logarithms of the integers from 50,000 to 100,000 to 16 places of decimals.

Table of Natural Logarithms, Volume III, Mathematical Tables Project; Work Projects Administration, New York, 1941; 501 pages, $2.00.

Logarithms of the decimal numbers from 0.0001 to 5.0000 to 16 places of decimals.

Table of Natural Logarithms, Volume IV, Mathematical Tables Project; Work Projects Administration, New York, 1941; 506 pages, $2.00.

Logarithms of the decimal numbers from 5.0000 to 10.0000 to 16 places of decimals.

Table of Sine and Cosine Integrals for Arguments from 10 to 100, Mathematical Tables Project; Work Projects Administration, New York, 1942; 185 pages, $2.00.

Values of these functions to ten decimal places from 10 to 100 at intervals of 0.01.

Table of the First Ten Powers of the Integers from 1 to 1000, Mathematical Tables Project; Work Projects Administration, New York, 1938; 80 pages, $0.50.

Tables of Circular and Hyperbolic Sines and Cosines for Radian Arguments, Mathematical Tables Project; Work Projects Administration, New York, 1939; 405 pages, $2.00.

Contains nine decimal place values of $\sin x$, $\cos x$, $\sinh x$ and $\cosh x$ for x (in radians) ranging from 0 to 2 at intervals of 0.0001.

Tables of Probability Functions, Volume I, Mathematical Tables Project; Work Projects Administration, New York, 1941; 302 pages, $2.00.

Values of these functions to 15 places of decimals from 0 to 1 at intervals of 0.0001 and 1 to 5.6 at intervals of 0.001.

Tables of Sine, Cosine, and Exponential Integrals, Volume I, Mathematical Tables Project; Work Projects Administration, New York, 1940; 444 pages, $2.00.

Values of these functions to nine places of decimals from 0 to 2 at intervals of 0.0001.

Tables of Sine, Cosine, and Exponential Integrals, Volume II, Mathematical Tables Project; Work Projects Administration, New York, 1940; 225 pages, $2.00.

Values of these functions to nine, ten or eleven significant figures from 0 to 10 at intervals of 0.001, with auxiliary tables.

Tables of Sines and Cosines for Radian Arguments, Mathematical Tables Project; Work Projects Administration, New York, 1940; 275 pages, $2.00.

Contains eight decimal place values of sines and cosines for radian arguments ranging from 0 to 25 at intervals of 0.001.

Tables of the Exponential Function e^x, Mathematical Tables Project; Work Projects Administration, New York, 1939; 535 pages, $2.00.

The value of this function to 18 places of decimals from -2.5 to 1 at intervals of 1.0000, to 15 places of decimals from 1 to 2.5 at intervals of 0.0001, to 15 places of decimals from 2.5 to 5 at intervals of 0.001, and to twelve places of decimals from 5 to 10 at intervals of 0.01.

Tables of the Moments of Inertia and Section Moduli of Ordinary Angles, Channels, and Bulb Angles with Certain Plate Combinations, Mathematical Table Project; Work Projects Administration, New York, 1941; 197 pages, $1.25.

Medicine

Adventures in Respiration; Modes of Asphyxiation and Methods of Resuscitation, by Yandell Henderson; Williams & Wilkins Co., Baltimore, 1938; 316 pages, $3.00.

This monograph on asphyxiation considers the relation between anoxia and acapnia, with particular reference to methods of resuscitation by the administration of oxygen and carbon dioxide.

Blood; A Study in General Physiology, by Lawrence J. Henderson; Yale University Press, New Haven, 1928; 397 pages, $5.00.

Quantitative and mathematical studies of the physicochemistry and physiology of the blood.

Carbon Monoxide Asphyxia, by Cecil K. Drinker; Oxford University Press, New York, 1938; 276 pages, $4.50.

The biochemistry, pathology, aftereffects and treatment of carbon monoxide poisoning are discussed, and methods for the detection and determination of carbon monoxide in the air and in the body are presented. A bibliography of several hundred references is included.

The Effects of Anoxia on Visual Function; A Study of Critical Frequency, by Clifford P. Seitz; Columbia University, New York, 1940; 38 pages, $0.80. (*Archives of Psychology*, No. 257)

A study of the effect of oxygen deprivation on the functions of the eye at altitudes equivalent to 17,500 and 20,000 ft. and at sea level, including observations on the effect of strychnine.

Fatigue in Aircraft Pilots, by Ross A. McFarland; Boston, 1941; 31 pages. (Reprinted from the *New England Journal of Medicine*, Vol. 225, pages 845–855.)

An analysis of the more important factors that contribute to pilot fatigue, such as muscular exertion, emotional stress, reduced oxygen tension in flights at high altitudes, diet and the use of stimulants, and the comfort of the pilot during flight.

The Internal Environment and Behavior—A Symposium, by Ross A. McFarland, Ernest Gellhorn, Edward F. Adolph, Nathan W. Schock, and Curt P. Richter; New York, 1941; 83 pages. (Reprinted from the *American Journal of Psychiatry*, January, March, May, 1941.)

A discussion of the relationships between the internal environment and behavior, especially the role played by oxygen, glucose, water and temperature, the acid base and internal secretions.

Ophthalmic Aspects of Acute Oxygen Deficiency, by Ross A. McFarland, J. N. Evans, and M. H. Halperin; Chicago, 1941; 28 pages. (Reprinted, with additions, from the *Archives of Ophthalmology*, November, 1941.)

A survey of studies made to determine alterations in visual functions due to acute anoxia.

Physiology of Muscular Activity, by Edward C. Schneider; 2nd Edition, Revised; W. B. Saunders Co., Philadelphia, 1939; 428 pages, $3.00.

The effects of physical exertion on the body processes, including a chapter on adaptation and physical exertion at high altitudes.

Psychology in South America, by J. G. Beebe-Center and Ross A. McFarland; Evanston, Ill., 1941; 41 pages. (Reprinted from the *Psychological Bulletin*, October, 1941.)

The history and development of psychologic science and research facilities in the South American countries and the work accomplished by various men in this field are sketched briefly. A selected bibliography of South American psychologic literature and periodicals and a partial list of South American psychologists are appended.

Meteorology

An Introduction to Elementary Meteorology, by R. W. House; House's Air Publications, Prestwick, Ayrshire, England, 1940; 39 pages, 1*s.* 6*d.*

A brief introduction intended for use with lectures.

The Observer's Book on Meteorology, by William Alexander and W. J. D. Allan; George Allen & Unwin, London, 1941; 110 pages, 2*s.* 6*d.*

A volume in the "Observer's Handbook" series, intended to explain the causes and reasons for changes of the weather in nontechnical language.

Military Aviation

Air Challenge and the Locusts, by Hugh Wansey Bayly; John Lane, The Bodley Head, London, 1939; 240 pages, 7*s.* 6*d.*

A critical examination of the conduct of British air defense, based on the Parliamentary debates, 1933–1939.

Air Strategy, by Norman Macmillan; Hutchinson & Co., London, 1941; 128 pages, 2*s.* 6*d.*

The modern concept of the air force and the factors that influence its growth and striking power.

Ballooning and Its Application to Kite-Balloons; A Course of Lectures on the Theory of Ballooning, Delivered before Officers at the Royal Air Force Station, Roehampton, 1916; Obtained from Practice, by Griffith Brewer; Air League of the British Empire, London, 1940; 65 pages, 1*s.* 6*d.*

The eleventh revised edition of a textbook first written in 1916, the present application of its principles being in the use of barrage balloons.

The Battle of Britain, 1940, by J. M. Spaight; Geoffrey Bles, London, 1941; 231 pages, 10*s.* 6*d.*

A description of the German air attack on England, beginning June 18, 1940, with comments on the technical and military problems of counter-offense and defense.

Carry On, London, by Ritchie Calder; English Universities Press, London, 1941; 163 pages, 5*s.*

An account of the bombing of England in 1940 and 1941, with emphasis on the work of the civilian population.

Defeating the Bomber, by H. E. Wimperis; J. M. Dent & Sons, London, 1941; 60 pages, 1*s.*

Nontechnical discussion of the means of defense against bombers.

The Lesson of London, by Ritchie Calder; Secker & Warburg, London, 1941; 128 pages, 2*s.*

This book describes the measures taken to alleviate suffering and dislocation of normal life during the bombing of London in 1940 and 1941.

R.A.F. Occasions, by H. G.; The Cresset Press, London, 1941; 301 pages, 8*s.* 6*d.*

Personal impressions of R.A.F. characters and events during the first world war, the peace, and the present war, by a journalist who served as an observer and is now an administrative officer.

The Royal Air Force at War, by the Staff of *The Aeroplane;* book designed by William Buchan; John Murray and The Pilot Press, London, 1941; 72 pages, 6*s.*

A revised edition of this résumé of the role of the Royal Air Force in the war. Illustrated with numerous photographs.

The Sky's the Limit; A Study of British Air Power, by J. M. Spaight; Hodder and Stoughton, London, 1940; 160 pages, 3*s.* 6*d.*

The re-creation of British air power is the subject of this book by a former assistant secretary in the British Air Ministry.

The Fight for Freedom; George Philip & Son, London, 1941; 31 pages, 6*d.*

Short biographic sketches and photographs of leaders and statesmen of the British Empire in the present war.

Der Zivile Luftschutz, by Max Höriger; B. Wepf & Co., Verlag, Basel, 1935; 120 pages.

A guide for air-raid precaution services and the civilian population, describing the properties of many types of poisonous gases, and methods of protection during enemy attack.

The Royal Air Force from September 1939 to December 1940, by L. E. O. Charlton; Hutchinson & Co., Ltd., London, 1941; 320 pages, 21*s.*

The development and activities of the Royal Air Force during the first 15 months of the present war, with numerous illustrations taken from photographs and drawings.

Miscellaneous

Aeronautical Occupations, by Burr Leyson; new, revised edition; E. P. Dutton & Co., New York, 1941; 187 pages, $2.00.

Available positions, job qualifications and educational opportunities are outlined with a view to assisting those who wish to make aviation their career.

Analytical Computations in Aerial Photogrammetry, by Earl Church; Edwards Brothers, Ann Arbor, Mich., 1936; 142 pages.

The theory and mathematical methods underlying the use of aerial photogrammetry in surveying.

Letter Language, compiled by Peter F. Murray; Rolls House Publishing Co., London, 1941; 40 pages, 6*d.*

This vest-pocket size handbook lists abbreviations in common use by the Royal Air Force and in civil aviation.

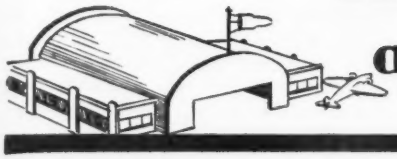
The Modern Airport, by Sterling R. Wagner; New York State College of Forestry, Syracuse, New York, 1931; 108 pages.

The location, design, construction and management of airports, together with a suggested design for the municipal airport at Syracuse, N.Y.

Physical Science in Art and Industry, by E. G. Richardson; The English Universities Press, Ltd., London, 1940; 293 pages, 15*s.*

The applications of modern physics to the solution of engineering problems are given, including a short chapter on recent aeronautical progress.

House Organs and Catalogues



Supplement to Dimensional Control Book

Gaging Policy is the title of a booklet of 15 pages issued as a supplement to the book, *Dimensional Control*. Advice on selection and specification of gauges is intended to aid in reducing rejections and thus contribute to more efficient production at lower cost. Gauge makers' tolerances are explained and tabulated. Pages are devoted to allocation of gauge tolerance and wear allowance, illustrated by drawings and charts. Army Ordnance practice is explained, as well as the application of gauge tolerances and wear allowances to thread gauges. Instructions are included for the development of a gauging policy and on the ordering of gauges. *The Sheffield Corporation*, Dayton, O.

Cowling Fasteners

A revised catalogue has recently been made available, containing corrected information and specifications on Airloc cowling fasteners which are made in sizes $^3/_4$ in., 1 in. and $1^3/_8$ in. It supersedes all previous data on these devices. Drawings, tables and detailed information are included on the fastener assemblies and their individual parts. A leaflet is inserted giving instructions for ordering these fasteners.

Special Airloc cowling fasteners for plywood are covered in a four-page leaflet which shows applications to this material and gives specifications and other data. *United Carr Fastener Corporation*, Cambridge, Mass.

Alloys for Aircraft Parts

An illustrated bulletin entitled *How Aircraft Designing Engineers Use Ampco Metal* shows applications of Ampco alloys to the manufacture of parts for aircraft engines, propellers, landing gear, tail wheels and accessories.

Also offered is a booklet entitled *Brief Facts About Ampco Metal*, listing and describing the physical properties and uses of these bronze alloys. Micrographs show the structure of the different grades. *Ampco Metal, Inc.*, Milwaukee, Wis.

Precision Manufacture

Manhours Required to Make Aircraft Prop More Than Double That of an Automobile. The reason why it takes four full days to complete a hydromatic, variable pitch, aircraft propeller is explained. It is pointed out that in the hub alone there are more than 100 parts that must be fitted together with watch-like precision. The successive steps in the manufacture and inspection of full feathering airplane propellers are outlined. *Automotive War Production*, September.

Realistic Training

The Crewtrainer at Work. Interior views and a flight photograph are presented of the Boeing AT-15, which was specifically designed for the integrated training of bomber crews. Resembling a twin-engined bomber in appearance, the new plane's mission is to give the flight crews the training in coordination and teamwork to prepare them for their tactical duties in multiengined bombers. Equipment of the new model includes constant-speed propellers, radio compass, automatic pilot, radio and flight instruments, flexible machine gun, power turret and bomb bays. To save critical materials the AT-15 is constructed of steel tubing with wood-faired fabric-covered fuselage, and the wings and tail surfaces are covered with plywood. *Boeing Contact*, September.

Airplane Testing

Flight Testing at Vought-Sikorsky Aircraft. This article briefly describes modern methods of aircraft flight testing and tells how tests are carried out at Vought-Sikorsky Aircraft. It is explained that three distinct types of tests are given to all airplanes. There are experimental tests of a new model, tests of the first production model, and production tests of an accepted model. Some information is given on how each of these tests is conducted. *The Bee-Hive*, August.

Electrical Connectors

The Cannon Electric Development Company has just issued a new condensed catalogue supplement covering numerous types of electrical connectors.

This catalogue deals briefly with the two leading types used in aircraft applications and details more complete information on connectors for radio microphones, sound equipment; power heavy-duty control circuits, public address systems and geophysical research; electronic low-level circuits and small power applications. The 16-page catalogue is illustrated. *Cannon Electric Development Company*, Los Angeles, Calif.

Aircraft Welding Department

Putting the Heat on Production. This is an interpretation of the work being done by the Bell Aircraft Corporation's welding department. Gas, tack, aluminum, and steel welding are explained. Operations and inspection subsequent to the actual welding are discussed. Other factors dealt with are the men in charge of the department and the training required to qualify personnel for it. *The Bellringer*, October.

Aviation Control Systems

A review of Automatic Electric's more important contributions to the aviation field is presented in a booklet entitled *Airport and Aircraft Communication and Control Systems.* The booklet contains twelve pages and covers the P.A.X. automatic interior telephone system and electric control systems for airport traffic, lighting and fire alarms. Automatic electric relays and other electrical control components used in aircraft are also described. Applications of the systems are illustrated.

The company also has published an 80-page catalogue entitled *Relays and Other Devices for Electrical Control.* This catalogue, which is designated as No. 4,071-C, furnishes information and specifications on the company's entire line of electrical control equipment. *Automatic Electric Company*, Chicago.

Crucible Steel Products

Folders are offered by the Crucible Steel Company of America on Rexalloy tipped tools, carbon steel drill rods, and Rex MM and MMM molybdenum high-speed steels. They contain specifications and information on these products. *Crucible Steel Company of America*, New York.

Flying Fortresses in Action

Round Trips by Day . . . . . Flying Fortress operations over the European continent during the month of August, 1942, are given, with their successful

record said to have been based on a technique of accurate bombing, high-altitude flying, and broad daylight raids. A point particularly stressed is that the number of casualties among these bombers was amazingly low. In addition to maneuvers at Dieppe, other raids participated in by the B-17's were over Cherbourg, Dunkirk, the North Sea, Amiens, LeTrait, Rotterdam, Meaulte, Wevelghen, Abbeville, Rouen and Utrecht. *Boeing News*, September.

Engine-Cleaning Bulletin

A concise technical bulletin published by the Curran Corporation describes the three fundamental steps necessary in airplane-engine cleaning and paint stripping at major overhaul time.

The pertinent material used as a basis for the information contained in the bulletin has been abstracted from many technical papers, as well as service specifications and manufacturers' literature, in such a way as to be presented in brief and convenient form. *Curran Corporation*, Malden, Mass.

Rules for Die Cushion Size

The Dayton Rogers Mfg. Co., has issued a page of rules for finding die cushion size or ring-holding pressure required on the cushion when the dimensions of the first draw shell are available. Compiled on a trial-and-error method of research covering five years, it is stated that the rules have been found satisfactory in practice. A second sheet presents information and specifications on the company's Model "C" pneumatic die cushions. *Dayton Rogers Mfg. Co.*, Minneapolis, Minn.

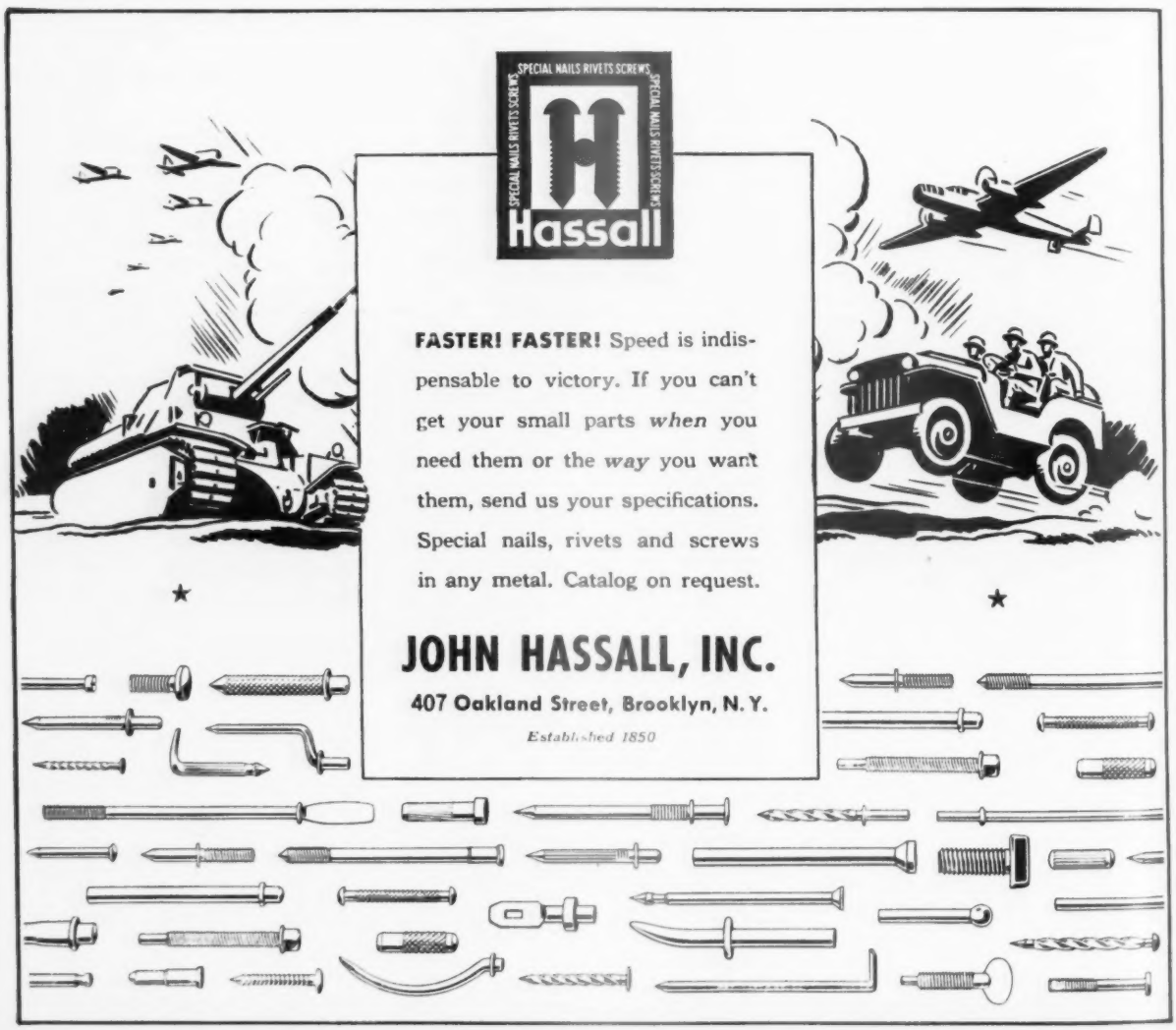
Training by Movies

Now Showing. Boeing Aircraft Corporation has a special department making motion pictures to facilitate the training program of its employees. Covering shop procedure throughout the factory, these pictures furnish visual instruction in machine operation, assembly work and general production processes. This article outlines the procedure followed in making the films, relates the equipment used, and introduces the men responsible for the successful functioning of the Visual Education Unit.

Three of a projected series of ten pictures have been completed. The first, called *Starting Engines*, shows all phases of a mechanic's work in warming up a Flying Fortress engine for the pilot. The two others, also concerned with the mechanic's work, are titled *Twenty-Five-Hour Inspection* and *Handling the B-17*. *Boeing News*, September.

Handbooks on Plywood Uses

A catalogue of industrial uses of fir plywood and a handbook of plywood technical data for engineers and architects have been published by the fir plywood industry. Both are in loose-leaf form and supplements will be issued frequently and forwarded to holders of the books. The industrial handbook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FASTER! FASTER! Speed is indispensable to victory. If you can't get your small parts when you need them or the way you want them, send us your specifications. Special nails, rivets and screws in any metal. Catalog on request.
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is a collection of selected articles telling of new commercial (nonconstruction) plywood applications. General information about grades, physical properties and handling of fir plywood also is included. In the binder, three sections cover physical characteristics of plywood, designing with plywood, and prevention of condensation in walls.

A table established by U.S. Forest Products Laboratory engineers gives approximate methods for calculating the strength of plywood. Other tables, charts and diagrams relating to strength properties under tension, compression, and flexure and shear, supplement the text. A table of moments of inertia is given. Two other sections treating with deflection and insulation properties of plywood are being printed now and will be sent to all holders of the technical handbook for insertion. *Douglas Fir Plywood Association*, Tacoma, Wash.

Trainer Aircraft

Trainer Wings for War Birds. Various types of training airplanes developed and built by Curtiss-Wright are reviewed. These fall into three fundamental divisions, including the primary trainer, the basic trainer and the advanced trainer, but another classification has recently been added, known as the transitional trainer. Its purpose is to duplicate as nearly as possible the flight characteristics and operation of the medium and heavy bombers used in actual war service. Specific trainers and their uses are discussed. *Curtiss Fly Leaf*, July–August.

Magneto Maintenance Booklet

Maintenance and repair information on Eisemann Model "AM" magnetos is furnished in an eight-page folder. Recent production changes and constructional details are covered. Illustrations and drawings of component parts and complete units are included. *Eisemann Magneto Corporation*, New York.

Training Courses Within the Aircraft Factory

Boeing Aircraft College. Details are given on a new system of supplemental training for employees devised by the educational department of Boeing Aircraft Company. In this system, a class in any particular subject is instructed by an employee suggested by the foreman of that department. During the course the instructor keeps the foreman constantly informed on the progress of his students and when promotions are made or vacancies filled in the department, these classroom records are taken into consideration. The practicality of the courses is established by the fact that they are set up by the shop foremen and department heads. Employees are advised by the education office on what courses to take and what sequence to take them in. *Boeing News*, September.

Infrared Lamp Equipment

A catalogue is offered on Fostoria infrared lamps for use in the infrared process for drying lacquers. The process and the various models of lamp equipment manufactured by the company are described. Illustrations show applications of the process in the aircraft and other industries. *The Fostoria Pressed Steel Corporation*, Fostoria, O.

Motion Picture on Lathes

A new sound and color motion picture, *Turret Lathes—Their Operation and Use*, produced at the direction of the manufacturer by Burton-Holmes Films, Inc., is designed to aid in training new machine-shop employees.

Subject matter covered includes a comparison of the turret lathe with other metalworking machines and detailed sequences illustrating the basic types of work done on a turret lathe and the production methods followed in each case. The film is of the 16-mm. size; it will be available to all recognized trade schools, technical schools, manufacturers, and the like—at no charge. *Gisholt Machine Company*, Madison, Wis.

How Aluminum is Made

From Rattle to Battle. Robert Neville. The history of the development of aluminum is related in detail from its discovery in 1825 to its vitally important place today as the major structural component of airplanes. Supplementing this is an outline of the mining and manufacturing processes involved in the production of aluminum, as well as a summary of the purposes for which it has been utilized. Its characteristics and the many ways in which it can be fabricated—rolled into sheets, machined, cast drawn, extruded, or die cast—are noted. Mention is also made of the men responsible for its development. *Douglas Airview*, August.

Light Plane Engines

Information on Lycoming light plane engines is presented in a four-page folder. General features of the company's series of 50- to 75-hp. four-cylinder opposed air-cooled engines are described. Included in the folder are tables giving the specifications of the four models offered. *Lycoming Division, Aviation Manufacturing Corporation*, Williamsport, Pa.

Catalogue of Screw Products

Stronghold screw products are described in Catalogue No. 14. This catalogue contains 96 pages, the first section of which is devoted to specifications of aeronautical nuts, screws and washers. There is a table of American standard machine screws. Many other types of screws, bolts and nuts are listed. *Manufacturers Screw Products*, Chicago.

Air Commerce

Post-War Skies. Wayne W. Parrish. The writer points out factors that have retarded the development of air transport, discusses progress in this field up to the present, and draws a picture of future developments. He believes supercargo planes will shrink the world, enhance inland commerce, and make America first in the air. He states that the airplane may never entirely supplant the steamship, as the railroad never entirely supplanted the inland waterway or the motor truck the railroad, but that the time is coming when the cargo plane will be a dominant factor in international commerce. *The Exchangite*, August.

Petroleum Testing Apparatus

The Precision Scientific Company has published Catalog 700, *Apparatus for Testing Petroleum Products*, consisting of 96 pages with index. It presents detailed information on apparatus for standard methods of testing asphalt, bituminous materials, automotive and aviation fuels and lubricants, conforming to specifications of the American Society for Testing Materials, Federal Specification Board, British Petroleum Institute, American Association of State Highway Officials, and other governing bodies. Also included are laboratory utilities and a compilation of data on thermometers used for petroleum inspection. *Precision Scientific Company*, Chicago.

Thermoplastic Lenses

Optical properties of Plexiglas are described in considerable detail in a 40-page illustrated booklet. Optical constants of Plexiglas are given, and the techniques by which these values were obtained are described so that the reader may properly interpret and evaluate them. Information on applications of the material also is presented. *Rohm & Haas Company, Inc.*, Philadelphia.

Tool Engineering

Tooling Up at Fleetwings. John J. Scheppe. An article describing Fleetwings' tool engineering department and how it has contributed to making possible high production output. The tool engineering department is made up of nine different sections. The writer outlines the various steps in manufacture from the time blueprints are released from the production engineering division. He also tells how a system of isometric three-dimensional drawings for assembly-line operators was developed for the purpose of clarifying instructions. *The Fleetwings' Arrow*, September.

Material Analysts

Material Control Group. Jim Pegues, Wally Bison, and Jim Collins. The functions of the Lockheed-Vega Engineering Material Control Group are outlined. It is the responsibility of the members of this department to see that all released drawings call for materials and parts that are standard and which can be obtained in time to conform with production schedules. They must also set up records of these parts and materials and originate such paper work as may be necessary to insure their being ordered and received on time. *Lockheed Vega Aircraftsman*, September.

High-Altitude Chambers

A new catalogue of twelve pages describes and illustrates the Tenney-Zphere high-altitude chamber. Provision is made in the apparatus for electrical and mechanical connections to facilitate the testing of devices inside the chamber where high-altitude atmospheric conditions of pressure, temperature and humidity can be reproduced. Standard equipment is designed to achieve the equivalent of 50,000 ft. of altitude in $7\frac{1}{2}$ min. and the rate of evacuation can be altered to meet specific requirements. The equipment of the chamber is detailed and the specifications of numerous installations are tabulated. *Tenney Engineering, Inc.*, Montclair, N.J.

Lift Truck Catalogue

A 40-page catalogue describing the Towmotor lift truck for industrial applications has been issued. This catalogue is divided into six sections covering design; frame construction; lifting and stacking mechanism; power-plant and travel mechanism; operating and control mechanism; and servicing and maintenance features. The power plant is a four-cylinder gasoline engine protected on all sides by the steel frame of the truck. The transmission has two speeds forward and two speeds reverse. A gear-type oil pump connected directly to the crankshaft supplies oil to the hoist cylinder. *Towmotor Company*, Cleveland, O.

Engineering Services

Here's What Engineers Do. Functions and responsibilities of the engineering staff of an airplane manufacturing company are explained. What each major division of the engineering department does, how it performs its work and the relation of its duties to other plant operations are given. Each step in the process of design and supervision of production is traced from the inception of the confidential design to the work of the field service engineers after the airplane has been delivered. *North American Skyline*, September.

Copper Plating Process

A six-page leaflet describing the Unichrome alkaline copper plating process has been published. This plating process is used on connection with the deep-drawing of steel parts, where a ductile, adherent coating of copper is required to act as a lubricant between the work and the drawing dies. The process is also employed in the selective carburizing of gears, shafts and other steel parts. The leaflet also describes an alkaline stripping both developed for the removal of copper coatings. *United Chromium, Inc.*, New York.

Uses for Plastics

A 15-page booklet has been prepared containing suggested uses for plastics with particular reference to war production needs. Uses for plastic tubes, rods, wire, thread and supplies are covered. A table on the general properties of plastics is furnished. *R. D. Werner Company, Inc.*, New York.

Industrial Air Cleaner

A six-page bulletin describing the use of the Precipitron electric air cleaner in war industry production has been announced The new bulletin covers seven outstanding applications with

3 THINGS TO DO

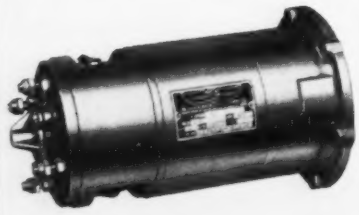
IF YOU ARE PLANNING A *NEW* PRODUCT WHICH REQUIRES A

Special Application Motor

1 Consider the suppliers with the most successful experience in the design and manufacture of special application (fractional horsepower) motors.

2 While the product is still in the early stages of development, select the company which in your judgment is best qualified to work with you in solving the problem.

3 Place your motor problem entirely in their hands or permit their engineering department to work with yours.



Many manufacturers have found that we fulfill all these important requirements both from the standpoint of engineering and production.

Write us about your problem and we shall be glad to send full information or arrange to have one of our representatives call.

THE BLACK & DECKER ELECTRIC CO.
KENT, OHIO

FRACTIONAL HORSEPOWER ★ SPECIAL APPLICATION

BLACK & DECKER

MOTORS

illustrations of each, and outlines of the results.

A description of how the air cleaner operates is supplemented by cutaway views of the power pack and the cells. A cutaway view of a typical air duct shows the Precipitron air cleaner as the cleaning component of an air-conditioning system. *Westinghouse Electric & Manufacturing Company.*

Last-Minute Changes

Just Before the Battle. After a North American B-25 has been completed, tested and accepted for the Army, some last-minute alterations are frequently necessary to adapt the plane for some special task or to cope with unusual conditions which it may meet. These changes are made at what is known as the modification center. The work of that section is described. *North American Skyline*, September.

How Airplanes Are Created

An Airplane Is Born. Palmer Wentworth. The story of the development of a new airplane, as carried out by the Ryan Aeronautical Company, is presented. Preliminary study and design are taken up in this article, which is the first of a series. After the management has decided that a certain type of airplane may prove successful, a design study is made by a group of development engineers. Details of this phase of the work are discussed. *Ryan Flying Reporter*, September 18.

Instruction for Army Air Force Navigators

Avigator Anniversary. The celebration of its second birthday occasions a review of the first two years of existence of Pan American's Navigation School at Miami, Fla., where U.S. Army Air Force and Royal Air Force cadets have been trained in the fundamentals of navigation. Exploits of individual alumni are cited as the best proof of the school's success. Introduction is also given to the men comprising the instructors' staff. *New Horizons*, August.

Electric Instrument Bulletin

In Shallcross Bulletin D-1 the company's No. 630 Wheatstone bridge is featured. This is a basic electrical measuring instrument suitable for production testing in laboratories and manufacturing plants. The No. 621-A limit bridge and the No. 638-1 Kelvin Wheatstone bridge also are described. *Shallcross Manufacturing Company*, Philadelphia.

Data on Alternate Steels

The Society of Automotive Engineers has issued an addition to the Aeronautical Material Specification series consisting of 17 sheets covering new specifications for aeronautical alternate steels. They include data on composition, grain size, condition, quality and tolerances. *Society of Automotive Engineers, Inc.*, New York.

Materials Problem Solved

Mexican Plywood Trainer Answers Priority Difficulties. This article describes how the Chief of the Mexican Air Force and a Mexican aeronautical engineer designed and built a low-wing trainer constructed entirely of native materials. It is stated that this airplane is capable of being repaired in the field by any skilled woodworker. The Lycoming 125-hp. model 0-290 engine was chosen as standard equipment for these trainers. Performance figures for the trainer are given. *The Lycoming Star*, September.

Incendiary Bombs

Information on the action and control of fire bombs and the fires they start is presented in a 29-page booklet entitled *When a Fire Bomb Strikes*, published by the Socony-Vacuum Oil Company. Recommendations in this booklet are not intended to supersede prescribed air-raid precaution procedure or official defense regulations but to supplement them with facts obtained by actual tests from authoritative sources. The most frequently used types of fire bomb can be dealt with successfully by even a woman or a child, without hazard, if correct procedure is followed. The writer attempts to alleviate the fear of fire bombs by those who have to control them, emphasizing that they are not to be feared but respected. Fire bombs are classified as belonging in general to two main groups: the large scatter type, and the intensive type that burns where it comes to rest. Different forms of each type are described and the various methods of controlling fire bombs are explained in considerable detail. Illustrations aid the reader in understanding the problem. *Socony-Vacuum Oil Company, Inc.*

Test House

Muted Tester. The operation and purpose of Pan American's motor-testing building at Pan American Field, Miami, are described in detail. After 550 hours of active service in the air, the engine of every Pan American Clipper undergoes a thorough overhaul and inspection; it must then be tested in this building or similar ones before it can be installed for use again. Two special features of this particular test house are indicated: (1) It is designed so that the roar of the engines is muffled; (2) each of its test rooms has suspended engine mountings, said to simulate flying conditions more exactly than the solid ones usually used. *New Horizons*, August.

Lathe Books

Keep Your Lathe Clean is the first of a series of bulletins based on the theme "How to Get the Most Out of Your Lathes." This 16-page bulletin, H-1, shows how keeping lathes clean will help increase production, reduce scrap and lengthen the life of the lathe. The importance of periodic cleaning of all machine tools is emphasized by reference to the damage that can be caused by accumulated dirt and chips.

Bulletin 1004 describes South Bend turret lathes Nos. 1003-C and 1004-C, covering bench model turret lathes and their construction features. Tabulated specifications furnish information concerning capacities, feeds, speeds, and dimensions. These turret lathes are designed for the performance of small chucking and bar work to close tolerances.

Catalogue No. 13 covers South Bend 13 in. toolroom lathes and engine lathes. Attachments, accessories and tools for use with the lathes are also listed. A portion of the catalogue is devoted to the construction features of the quick-change gear box, carriage, spindle bearings, motor drive, etc. These lathes have a $13\frac{1}{8}$ in. swing over the bed and saddle wings, $\frac{11}{16}$ in. collet capacity, 1 in. spindle bore, and are made in several bed lengths that provide between-centers capacities of 16 in. to 52 in. The eight spindle speeds provide a range from 34 to 875 r.p.m. A full page of tabulated specifications gives essential information on capacities, feeds, speeds, and dimensions. *South Bend Lathe Works*, South Bend, Ind.

Folder on Steel Tubing

A folder has been published on seamless steel tubing manufactured by the Summerville Tubing Company. Standard and special shapes of tubing are described. Illustrations show some typical examples of special tubing and parts. One page is devoted to a description of X-ray housings made of tubing. *Summerville Tubing Company*, Bridgeport, Pa.

Vega Engineering 1937–1940

Engineering the Early Vegas. Vince Trotter. The progression of planes developed by the engineering department of Vega is followed from its inception in 1937 to the initial production of military designs in 1941. Among the development assignments surveyed are: the "Flying Test Stand," which utilized the Unitwin power plant; the Starliner, a six-passenger commercial transport also employing the Unitwin engine; Lockheed Model 212; and complete power nacelle installations of British and American transports. *Lockheed Vega Aircraftsman*, September.

An Appreciation to Corporate Members of the Institute of the Aeronautical Sciences

Listed below are the leading aeronautical and industrial companies who make possible the publication of the *Journal of the Aeronautical Sciences* through Corporate Membership Dues.

The income from these dues enables the Institute to publish scientific and technical papers in the *Journal* without advertising and to devote its pages exclusively to editorial material.

The *Aeronautical Engineering Review* is devoted to the dissemination of current aeronautical information and advertising defrays part of its publication expense.

The above publications provide a source of comprehensive technical information for the benefit of the aeronautical profession and industry.

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Adel Precision Products Corporation
Aero Insurance Underwriters
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Airesearch Manufacturing Company
Aircraft Radio Corporation
Allison Division, General Motors Corp.
Aluminum Company of America
American Airlines
American Bosch Corporation
The American Rolling Mill Company
American Tube Bending Company, Inc.
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Beech Aircraft Corporation
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  Bendix Aviation Ltd.
  Bendix Products Division
  Bendix Radio Corporation
  Eclipse Aviation Division
  Export Division
  Julien P. Friez & Sons Division
  Pioneer Instrument Division
  Scintilla Magneto Company
Boeing Aircraft Company
Boeing School of Aeronautics
Bolton Manufacturing Company
Breeze Corporations, Inc.
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Eaton Manufacturing Company
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Standard Oil Company of California
Standard Oil Company (Indiana)
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Summerill Tubing Company
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Thompson Products, Inc.
Transcontinental & Western Air, Inc.
United Aircraft Corporation
  Hamilton Standard Propellers Division
  Pratt & Whitney Aircraft Division
  Vought-Sikorsky Aircraft Division
United Air Lines Transport Corporation
United States Aviation Underwriters, Inc.
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Warner Aircraft Corporation
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Westinghouse Electric and Mfg. Company
Wyman-Gordon Company

From the Industry

New Corporation for Aircraft Product Development

Announcement has been made of the formation of the Aircraft Parts Development Corporation with offices, laboratories and shops in Summit, N.J.

This organization will handle research and development work on parts and materials for the aircraft industry, especially in the fields of fastening devices, powdered metals, and plastics. It is planned to solicit ideas and untested projects from engineers and inventors, and to carry them through complete development to the point of release for commercial manufacture. Activity will extend to the designing and tooling of any special machinery required for the manufacture of products evolved.

Facilities include a fully equipped toolroom, special experimental machinery, a powdered-metal experimental laboratory, and a pilot thermoplastics plant. The executive and technical personnel of the organization will be announced in a few weeks. Aircraft Parts Development Corporation, Summit, N.J.

Steam Chamber for Curing Laminated Wood, Plastics and Synthetics

To meet new and varied vulcanizing requirements the American Tire Machinery Company has introduced its Vitacap chamber to the war industries for the curing of laminated (hot form) plywood, plastics and synthetics. The Vitacap chamber is not a new machine. For four years members of the tire and rubber industry have operated Vitacap units for live-steam curing. The manufacturer reports that several aircraft and specialty manufacturers are operating these devices.

According to the manufacturer, heads and other materials are on hand for constructing Vitacap chambers in diameter dimensions of 45, 56, 75, or 90 in. In addition, the manufacturer states that special materials are available for manufacturing chambers of other overall diameters and lengths.

The chamber is locked by two clamp ring halves which encircle the entire circumference of the unit and lock the door and body flanges. Two bolts, one on each side of the chamber, tighten the clamp ring halves in position, thereby sealing the curing vessel.

Vitacap chambers are built and tested to a working pressure of 90 lbs. In addition to straight steam hookup, the chamber may be used for high-pressure, low-temperature curing through a combination air-steam installation. The chamber is recommended by the maker for the curing of laminated or hot-form plywood, plastics, synthetics, or other material requiring open-steam vulcanizing. American Tire Machinery Company, Los Angeles.

Instruments Tested Under Temperature Extremes

A new chamber for testing instruments under extremes of cold and heat has been developed and is now manufactured by American Coils, Inc. Its range of operating temperatures extends from $-55°$ to $+70°$C. It includes apparatus for mechanical refrigerating and electrical heating.

Known as Model RTC-1, the test chamber consists of a two-stage condensing unit, heat exchanger, liquid subcooler, coil or evaporator, expansion valves, cabinet and forced-draft strip heater, along with thermostats and other controls and connections for each. The entire operation of the Model RTC-1 is controlled from a front panel board, where the master switch is located along with the off-fan control, light switch and receptacle switch.

This automatic testing cabinet is in itself a precision machine and when used to test instruments is said to assure scientific control of all temperatures. It can reproduce whatever temperature is desired and a temperature at any level so that actual service conditions may be created. The Model RTC-1 also provides positive air circulation.

The all-steel cabinet occupies space 83 in. wide by $56\frac{1}{2}$ in. high by 42 in. deep. The usable interior is 59 in. wide by 28 in. high by 30 in. deep, with an interior cubic content of 28.7 cu.ft. The cabinet contains 6 in. of Fiberglas insulation. American Coils, Inc., Newark, N.J.

New Dy-Namic Balancers

Bear Dy-Namic balancing machines are claimed to embody a new sensitive and accurate balancing principle that makes possible a low-cost and easily operated machine.

These balancing machines indicate the disturbing centrifugal force or force couple with a high degree of accuracy. Both the angular position and the value or amount of unbalance is shown at the same time. The balancing machine reveals whether a static or dynamic unbalance, or both, are present without reversing ends of the body being balanced.

Bear balancing machines are available in a variety of models ranging from bench models to large floor and pit-type models for balancing such rotating parts as armatures, fans, blowers, flywheels, hubs, drums, propellers, gears, impellers, pulleys, wheels, rotors, etc., weighing from 6 oz. to 1,000 lbs. Bear Manufacturing Company, Industrial Division, Rock Island, Ill.

Substitute for Restricted Materials

A new powder metallurgy product, known as "Powdiron," is offered as a substitute for critical materials. Made of metal powders, die-formed to accuracy and sintered at high temperatures, Powdiron parts and bearings are said to effect a saving in material and an elimination of machining. It can be obtained either with or without lubricant impregnation with up to 25 per cent oil content. Three distinct formulas are adaptable for specifications providing porous iron alloys containing no tin or copper from 0 to 10 per cent maximum. Powdiron 55-P is a porous iron-bearing alloy containing no tin and only 5 per cent copper. Like all ferrous alloys, it is subject to corrosion under certain conditions but it is claimed that, because of its protective film of oil, it will show less tendency to corrode than other alloys. Powdiron 61-1C contains no tin and 10 per cent of copper, while Powdiron 59-1 is a straight iron material. Bound Brook Oil-Less Bearing Company, Bound Brook, N.J.

Standardization of Special Tools

In order to eliminate any great amount of special tool designing on the part of carbide tool users, as well as to speed deliveries of many formerly "special" tools, Carboloy Company, Inc., has announced a series of "design standards." They enable eliminating the time interval normally required to prepare design drawings, figure quota-

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● ***Mentioned above are only a few of the many Cambridge instruments for use in industry, science and medicine. The wide variety of Cambridge instruments available for improving quality and quantity of output, as well as ability to fly, include VIBROGRAPHS, ACCELEROMETERS, FLUXMETERS, PYROMETERS, RECORDING GAS ANALYZERS for determining harmful components in CABIN ATMOSPHERES, and many other precision, mechanical and electrical instruments.***

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tions, prepare working drawings, special samples, etc. By eliminating minor variations that naturally result from individualized tool engineering, the great variety of many special tools and blanks have been reduced to a relatively small number of standard designs.

Among the varieties of tools and blanks for which design standards have now been established by Carboloy are: cut-off tools, roller turner tools, grooving tools, shear-type tools; Carboloy twist drill tips; plug gauge and ring gauge bushings; drill jig bushings; Carboloy guide rings; Carboloy twist drill stock; round, oval and half-round rod, rectangular rod, and Carboloy tubing.

"Standard Design" cut-off tools range from $^5/_8$ by $1^1/_4$ in. to 1 by 2 in. shank dimensions, the design standards including five sizes. Tips on these tools are on the right side of the shank when viewed from the top of the tool, the front end of the left part of the shank being chamfered at an angle of 45°. Blank widths range from $^3/_8$ in. on the smaller to $^1/_2$ in. on the larger cut-off tools. The tools have a back taper of $1^1/_2$° on each side to assure free cutting.

Roller turner tools, commonly called "box" tools, have been standardized for use on both Warner & Swasey and Gisholt type lathes. Designed with unusually large tips for maximum life and lower tool cost per piece, these tools are available in five design standards for W. & S. and two sizes for Gisholt lathes. The former range from $^3/_8$ in. by $^1/_2$ in. to 1 in. by $1^1/_4$ in. for shank size and are designed for use in W. & S. roller turners Nos. M-1370 to M-1375, inclusive. Two styles of such tools are available, one cutting with a 5° lead angle, which is the standard shape, while style No. 2 is designed for light cuts to a 90° shoulder. Gisholt roller turner tool types are designed to fit all sizes of Gisholt roller turners—with only two actual tool sizes. One of these has a 1 in. square shank while the other is $1^1/_4$ in. square.

Three classes of standard design grooving tools are now available, these classes differing only as to tolerances on tool width. Class "A" grooving tools are held to a total tolerance of 0.002 in., while Class "B" and "C" tools are held to tolerances of 0.001 and 0.0004 in., respectively. The size range—from 0.060 to 0.330 in.—for which grooving tools are available in standardized design cover approximately 95 per cent of all grooving requirement, it is estimated.

New shear type design standards are available in both left- and right-hand tool types and with shank dimensions ranging from 1 in. square to $1^1/_2$ by 2 in. They are available in both cast iron and steel cutting grades.

Carboloy tips for twist drills have been standardized as to design, enabling quicker delivery and quantity production in some 30 different sizes, ranging

from 1/8 to 1 5/8 in. diameter. Carboloy Company, Inc., Detroit, Mich.

Spacing Collar Adjusting Wrenches

Spacing collar adjusting wrenches are now furnished as part of the equipment included with the eleven different sizes of micrometer adjustable spacing collars for milling machine cutter arbors being manufactured by the Dayton Rogers Manufacturing Company.

These new double-end pin spanner wrenches make it possible for the operator to adjust the spacing collar to the desired adjustment by loosening the cutter arbor nut and adjusting the collar to the desired adjustment governed by the graduated micrometer sleeve. He then turns the collar to the desired direction as engraved on the outer sleeve of the micrometer barrel, thus eliminating hand adjustments and making it easier to effect the desired adjustments between large-diameter gang milling cutters. Dayton Rogers Manufacturing Company, Minneapolis, Minn.

Ignition and Corona Voltages Measured

A new electronic crest voltmeter announced by the General Electric Company is designed to measure ignition voltages of internal combustion engines; surge voltages caused by corona and surface discharges in the insulation on such electric equipment as motors, generators, and cables; and other repeated-impulse voltages up to 30,000 volts.

The instrument, weighing only 23 lbs., fills the need for a portable crest voltmeter for both laboratory and production testing. It is suitable for field measurement, such as trouble shooting and the determination of actual operating conditions, and can also be used for testing aircraft engines in flight.

The crest voltmeter can be used in areas where no electric power is available since it has a self-contained battery power supply. It can be moved readily to any location for testing purposes.

The voltmeter is equipped with an aircraft-instrument movement to provide resistance to vibration. It can be supplied marked and calibrated for any of the following scale ranges: 0–10,000 volts; 0–20,000 volts; 0–30,000 volts. General Electric Company.

Arc-Welding Electrode

Designed primarily for use in welding aircraft tubing and assemblies, a new electric arc-welding electrode to be known as Harcraft has been added to the P&H line. It will be supplied in a complete range of sizes in standard cut lengths. Production of the Harcraft electrodes is being pushed in order to make them quickly available to plants engaged in war work. Harnischfeger Corporation, Milwaukee, Wis.

Moisture Register for testing veneers and plywoods.

Moisture Content of Veneers and Plywood

A new model of moisture register, especially designed for determining moisture content of veneers and plywood, has been developed by Moisture Register Company.

The tests are made by electrode contact with the surface of material to be checked, the electrode being so designed as to develop an electrical field giving accurate results on material of thickness of 1/8 in. and less. The instrument gives accurate determinations in low moisture contents as well as high. It is calibrated with a range of from 0 to 25 per cent.

The surface of the moisture register electrode is completely smooth, which is said to prevent injury to the surface of material being checked. There are no points to cause injury or break off. The instrument provides a practically instantaneous reading. Moisture Register Company, Los Angeles, Calif.

"8 in 1" Manometer

The Meriam Company has designed a well-type direct reading manometer for testing aircraft instruments. A flexible scale arrangement enables this single instrument to test all aircraft instruments operating on the pressure or vacuum principle. It can be applied in laboratory and field servicing for checking calibration to determine functioning of such instruments as altimeters, air-speed indicators, rate-of-climb indicators, fuel pressure gauges, manifold pressure gauges, suction gauges, and automatic pilot sylphons and actuating diaphragms.

This manometer, known as Model A-338, incorporates an eight-sided scale selector, permitting the selection of proper scale for the particular aircraft instrument being checked. All scales are adjustable to suit barometric conditions in any specific locality and are direct reading in miles per hour, knots, pounds, inches, millimeters, etc. The range is from 0 to 61 in. of mercury or water. An integral return well prevents loss of indicating fluid. The Meriam Company, Cleveland, O.

Cable Insulation

Virtual elimination of the deteriorating effects of corona on the rubber insulation in airplane ignition cables has been achieved through the use of an ignition cable with an inner braid of Fiberglas fabric. Use of the cable during the past eight months is said to have cut ignition cable failures by approximately 50 per cent.

The cable consists of a core of copper wires, insulated with rubber with the Fiberglas inner braid, and the whole coated with a synthetic rubber-like jacket. The glass-fiber braid possesses high tensile strength, dielectric strength, insulation resistance and resistance to high temperatures.

The primary function of the inner braid is to increase the mechanical strength of the completed cable, keep it from stretching, and keep the insulation tightly sealed to the copper core. It also gives added body to the cable which decreases the action of "necking" when sealing grommets are used. The cable is so designed that the glass braid and entire cable is moisture-proof. With air space between the core and the insulation reduced to a minimum there is virtually no field for the damaging effects of corona. Owens-Corning Fiberglas Corporation, Toledo, O.

Aluminum Welding Equipment

Designed to achieve a maximum of speed, economy and operating simplicity in capacitor discharge welding of aluminum, a new line of rocker arm welders for stored energy resistance welding has been developed. These are available with the "Revers-O-Charge" capacitor discharge controls as well as "Frostrode" refrigerating units for below-freezing welding.

This rocker arm welder has a retractable stroke of 9 to 12 in. depending on throat depth. Retraction is accomplished by means of a fractional-horsepower motor driving a lead screw. The welding stroke has a range up to a maximum of 3 in. Rigidly locked yet slideable upper and lower arms may be adjusted in and out for throat depth or may be turned for angle mounting of electrodes when necessary.

Differential-action double air cylinders are used for the welding stroke, the cylinder for the return stroke being smaller than that for the pressure stroke. As a result, air pressure can be maintained continuously in the return stroke cylinder, insuring prompt point opening after completion of the weld and automatic discharge of the transformer secondary through a short-circuiting gun.

Point dressing is accomplished by exhausting the return stroke of the air cylinder by means of a three-way hand

valve located on the side of the machine. This allows the points to come together with just enough pressure to insure good point dressing.

In the "Revers-O-Charge" control, the voltage of the charge is controlled by a single external knob and the voltage can be raised and lowered without discharging condensers. Any one of eight different charging rates is available at the turn of a tap switch, while two tap switches enable the selection of any number of the capacitor units. The weld sequences are adjustable at the touch of a dial.

Many service difficulties have been removed by the reduction in moving parts and the elimination of several relays normally required in power circuits. All moving elements between condensers and welding transformers are eliminated.

In order to insure high efficiency and weld consistency in production, together with a minimum of point dressing, Progressive aluminum welding machines are designed for the use of "Frostrode" electrode refrigerating units. In the pedestal-type welder, the "Frostrode" unit is built into the base of the welding machine. Progressive Welder Company, Detroit, Mich.

For Uniform Welds

Revealed publicly for the first time at the National Metals Exposition in Cleveland, October 12 to 16, was a machine representing a new approach to "resistance welding." The "Temp-A-Trol" forge welder is claimed to make possible combined automatic spot-welding and heat-treating of alloy steels and heavy sections and permits the employment of relatively unskilled labor for spot-welding operations.

In general appearance, the "Temp-A-Trol" welder itself does not differ radically from conventional spot-welding machines. In operation, however, it employs a new method of control—the weld itself automatically controlling the functioning of the machine.

The flexibility and simplicity of operation of the "Temp-A-Trol" welder is demonstrated by the fact that, without changing the machine controls, welds of equal quality can be produced consecutively joining $1/4$ in. to $1/4$ in., or $3/16$ in. to $1/4$ in., or $1/4$ in. to $3/8$ in., or three sections of $1/4$-in. material at the same time.

In addition to this, the "Temp-A-Trol" welder can be used to heat-treat the weld in the same operation. This postheat refines the grain size of the weld, increasing its ductility, gives the proper grain structure, and "tempers" the weld nugget and adjacent area to any desired amount consistent with the characteristics of individual alloys. It is said to eliminate coarse and brittle grain structures when welding alloy steels and heavy sections.

To set the controls of the "Temp-A-Trol" welder it is necessary only to determine the temperatures that will produce the desired weld and heat-treat characteristics in any given material. The controls of the machine are then set to values corresponding to these temperatures. After the controls are once set, the machine will automatically compensate itself and reproduce identical quality welds under wide ranges of variation as to metal thickness, cleanliness of metal and other welding conditions.

The basic element of the control which makes this possible is the incorporation in one of the welding electrodes of a sensitive thermocouple. The thermocouple automatically shuts off the current when the correct temperature is reached, turns it on again when the weld has been cooled to the proper degree, turns it off when the correct heat-treat temperature has been reached, and so on.

Thus, instead of having a definite weld time and welding current with variable weld quality, the "Temp-A-Trol" is designed to reproduce a definite weld quality with automatically self-adjusting current and time cycles. To reduce production time and to provide

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better heating characteristics, current intensity and time are adjustably interlocked in "Temp-A-Trol" welding, the current intensity automatically increasing in proportion to the weld time required (up to preselected maximum).

The typical "Temp-A-Trol" control panel carries six "temperature" dials, operating in automatic sequence. They are so arranged that they will produce almost any desired variety of weld and heat-treat cycles—up to five individual heats and one common "cool." Progressive Welder Company, Detroit, Mich.

10-In. Turret Lathe

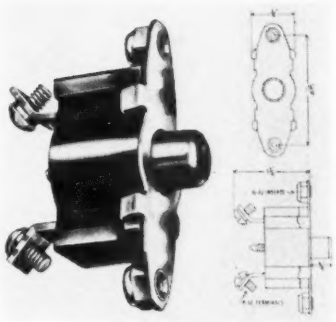
A new floor type turret lathe has recently been announced by the South Bend Lathe Works. It is designed for the rapid production to close tolerances of small chucking or bar work. Second operation work can also be handled efficiently. This lathe has a 10-in. swing over the bed or saddle wings, $1^3/_8$-in. hole through the headstock spindle, and 1-in. collet capacity.

The lathe is equipped with both a compound rest cross slide and a hand-lever cross slide, which are interchangeable. The latter is furnished with front and rear tool blocks which provide positions for three tools. A quick-change gear box supplies 48 longitudinal power feeds for the universal carriage, 48 power cross feeds for the compound rest cross slide, and 48 thread-cutting feeds, 4 to 224 per in. The hand-lever-operated bed turret indexes automatically and has an adjustable stop for each of the six turret tool positions. The underneath motor drive and back gears deliver twelve spindle speeds ranging from 50 to 1,357 r.p.m. The lathe is available either with or without coolant equipment. South Bend Lathe Works, South Bend, Ind.

Circuit Breaker

The new Klixon PSM circuit breaker, recently announced by the Spencer Thermostat Company, has the same mounting dimensions as the standard AN mechanical toggle switches. With this new breaker it is possible to bank switches close together on a panel and mount the breakers directly below each switch. Space is thereby saved and the installation is simplified and more convenient to operate.

Designed for use in airplanes, tanks, trucks and busses, this new Klixon PSM circuit breaker is a disc-operated device with manual reset which gives shock-proof and vibration-proof protection against harmful overloads. It is not, however, affected by harmless transient shorts. It has ample rupturing capacity and is available in close convenient ratings up to 35 amp. Self-locking inserts for mounting are standard, and the breakers can be had either with a plain or luminous-tipped reset button. Spencer Thermostat Company, Attleboro, Mass.



Klixon PSM Circuit Breaker.

Torque-Measuring Wrenches

A line of torque-measuring wrenches has been made available comprising eight models that range in size and capacity from small instrument-building wrenches of a low in.lb. capacity to heavy two-handled torque wrenches of 7,200 in.lbs. capacity.

These wrenches are being used for gauging or measuring torsional force, as when equalizing the set of screws or nuts by tightening to a predetermined torque, or for measuring the frictional drag in various mechanisms.

They are suitable for both manufacturing and inspection departments. All are of the flat tapered beam type with fixed end and top scales and are guaranteed by the manufacturer to retain their accuracy permanently. P. A. Sturtevant Company, Addison, Ill.

Protective Finish for Nuts

It is announced that, in accordance with approval by the production engineering section of the Army Air Forces, all future production of speed nuts will be furnished with a protective finish of Parkerizing, followed by zinc chromate primer. This change will become effective as rapidly as possible.

In some cases speed nuts will be required to have cadmium finish where they might serve to function as an electrical connector. For high-temperature applications regular stainless-steel types will be used. It is claimed that thorough tests have shown the new finish to be superior to the cadmium and that being nonmetallic it will serve to eliminate any galvanic corrosion. Tinnerman Products, Inc., Cleveland, O.

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Adjustable Fairlead Guide Block

A new "Speed-Align" adjustable fairlead guide block that is universal for any angle of cable is now being produced. This new guide block is composed of a three-piece macerated phenolic plastic guide that is housed between an aluminum base and a special spring-steel speed nut. The eccentric center plug is rotatable for centering cable. The plastic parts may be replaced without unthreading the cable. These guide blocks accommodate cables up to $^3/_{16}$ in. diameter and are boxed in single sets including Air Corps 530-8 screws and instructions for assembly.

Where a $^{29}/_{32}$ in. diameter hole is practical in structure, a slightly different block is used. This fairlead is exactly like the first, except that the aluminum base is not used. The plastic guide is housed in a $^{29}/_{32}$ in. diameter hole in the structure and is held firmly in place with the top Speed Nut.

Still another "Speed-Align" using a two-piece graphitized phenolic plastic guide is available. This is not only used as a fairlead for cables but is employed as a control rod bearing. Natural graphite is impregnated into the plastic so that the guide is self-lubricating. This fairlead is available in 15 different hole sizes to accommodate cables or control rods from $^1/_{16}$ to $^1/_2$ in. diameter. It is reported that these new fairleads greatly speed up the assembly of cables. They permit prepunching or drilling of fairlead holes and make unnecessary the drilling of angular holes in fairleads. Tinnerman Products, Inc., Cleveland, O.

Shock Refrigeration for Flying Suits

A periodic cycle of cooling and heating is proving to be the best method of protecting expensive wool-and-fur flying suits from moths while they are stored between flights. Because of their frequent use, the chemical treatment is said to be unsatisfactory and may even damage the furs.

The normal storage temperature is 35° to 40°F. In the "shock" cycle, the storage room temperature is reduced to 15°F. for several days to kill any larva that may be feeding. Then, by cutting off the refrigeration and introducing heat (usually from strip heaters in the supply duct or coil chamber), the storage room temperature is quickly raised to 50°F. where it is held for a few hours only. This causes any surviving larva to become active again and will hatch out any potentially dangerous eggs.

The temperature, after this few-hour period at 50°F., is again suddenly dropped to 15°F. for a day to kill off

the surviving larva and any larva newly hatched. After one day at 15°F. the temperature is brought back to the 35°F. or 40°F. storage condition.

This entire procedure is repeated at regular intervals or, to prevent reinfestation, when any appreciable quantity of untreated articles of clothing is placed in the storage room. Relative humidity is high enough to prevent drying and cracking of the fur skin but low enough to prevent mold or mildew. During the normal storage period with temperatures of 35° to 40°F., the relative humidity is about 50 to 65 per cent.

Typical installations include a flying school using an open-type 7½-hp. condensing unit with two-speed motor and a horizontal type air handling unit with refrigeration coil. At one typical aircraft factory three 25-hp. condensing units, four air handling units with refrigeration coils are used. Westinghouse Electric & Manufacturing Company.

Nofuze Circuit Breaker

A new type ANC air circuit breaker, designed to meet the circuit protection requirements on aircraft electrical systems, tanks, trucks, and similar mobile equipment using a direct current power supply of 28 volts or less, is announced by the Westinghouse Electric & Manufacturing Company.

Nofuze Circuit Breaker.

The breaker affords both circuit operation and protection in one compact unit that can be installed in the same mounting space as the present toggle switch. It permits individual circuit protection at every operating point with little or no increase in weight or space.

The ANC breakers have a rating of from 5 to 50 amp. at 28 volts d.c., and a 1,500 amp. interrupting capacity. The unit is manually operated with a 50° swing of the handle from the "off" to "on" position.

Circuit protection is accomplished by means of a bimetallic trip. One form of this breaker has a compensating element that will stabilize the rating of the breaker within certain limits of an ambient range from −60° to +135°F. This additional characteristic of the ANC circuit breaker is important on certain circuits for the protection of aircraft equipment. Westinghouse Electric & Manufacturing Company.

New Axle Jack

The aviation division of the Whiting Corporation is marketing the MHA-15 axle jack. This new unit is a hydraulic adjustable-step type jack designed to give long, heavy duty service. Lifting step pad is adjustable to two positions, 9½ and 13½ in. above the floor, and permanent stops prevent removal or loss of the pad. Single-action hydraulic pump provides fast operation; pump handle may be operated from either side of the pump and fits compactly in socket on the base when not in use. These jacks are also available in a standard 5-ton model (Type MHA-5) and in other capacities on special order. Whiting Corporation, Harvey, Ill.

The Whiting, Type MHW-17, 17-ton Wing Jack.

Matched Assembly Line Units

A trio of new matched assembly line units has just been announced by the aviation division, Whiting Corporation. The ETN group is designed to facilitate the handling and moving of any radial aircraft engine from the time it leaves its packing case through the final stage of the engine nacelle build-up. The three matched pieces of equipment include the following:

Model E engine cleaning stand, which supports the engine for all initial operations including wash-up and preliminary assembly of accessories. A two-way rotating arrangement permits holding an engine in any desired position.

Model T engine transfer carriage, which fits into Models E or N to simplify shifting engine from one unit to the other without overhead handling. This is accomplished by means of hydraulic

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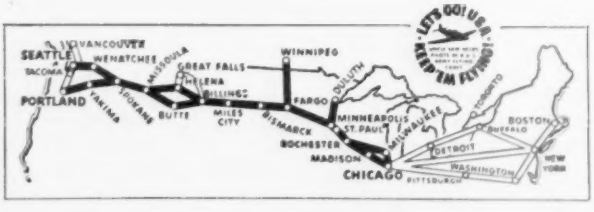


NORTHWEST AIRLINES

lift in the unit. It is also used for further installation of accessories.

Model N rotatable nacelle build-up unit, which provides a rotatable support for the final assembly of accessories, cowling, plumbing, wiring and other parts. Tubular construction throughout provides simplified design, maximum accessibility for every operation.

These units are available with varying capacities for all sizes of large radial engines. Whiting Corporation, Harvey, Ill.

Arc Control Stations for Welding Generators

Arc control stations in capacities of 75 and 150 amp. have been developed as auxiliary electric devices, connected in series with the welding circuit of any constant potential arc-welding generator. Most conventional drooping voltage generators can be converted quickly and easily to constant potential. For this purpose a quick-change switch is mounted on the generator. A portable switch held in the operator's hand gives the operator remote control of the welding current within predetermined limits. This switch may be combined with the electrode holder if desired.

When two or more arc control stations are connected to a single generator, a like number of welding arcs can be operated simultaneously. Each operator can regulate his own current and weld as he sees fit without affecting the other in any way. One of the important features of this new arrangement is the remote control of the arc when the operator reaches the end of a bead, thereby enabling him to improve the quality of the weld deposit at the crater. This is accomplished by gradually reducing the current which, in turn, reduces the heat and avoids porous, cracked craters and inclusions. Each operator has his choice of two methods of control: (1) He can set his control to deliver a definite current at the arc and weld steadily at that setting; or (2) he can use the hand switch to vary the current without breaking the arc. This enables him to start his arc on cold metal with a maximum current (hot arc) and to reduce the current as the work warms up. Wilson Welder & Metals Company, New York.

Desert Operating Problems

A fight against sand conditions so extreme that damaging grains can be pulled into an aircraft engine at altitudes of 12,000 to 15,000 ft. was described at the National Aircraft Production meeting of the Society of Automotive Engineers.

New improvements in air filters, developed by aircraft-engine builders and airplane manufacturers, are now being installed on a wide scale to help solve the problem, with the objective of returning operating time of engines to normal overhaul schedules. The worst part of the sand problem has been eliminated by building a special "sand mask" or air filter for the engine.

These filters are made of metal mesh or cloth mesh backed with metal, decreasing in size from large mesh to fine. Placed in the carburetor air intake, they screen out more than 90 per cent of the sand and still give the engine the air it needs for power. Some of the filters are soaked in lubricating oil before installation. These filters can be cleaned in gasoline after each flight and used again. The "dry" mesh screens are removed only after filling up with sand and are then discarded.

Studies of German planes shot down in the desert showed that they used retractable air filter systems. The pilot turns a valve to send the air flow through a filterless channel directly to the carburetor or switches the air flow to another intake passage equipped with a filter. This method gives more air flow and may be conducive to slightly more power unless the engine is already absorbing maximum air.

It was pointed out that while this method is possible on American planes, the extra control adds another burden on the already overloaded pilot, while in combat action or on fast take-offs to repel an attack the pilot may completely forget whether his filter is on or off. Also the sand in the desert areas is so fine that pilots frequently are not aware of dust "clouds," with the result that while flying at high altitude through what seems to be clear air they might actually be pulling in abrasive sand.

It is now believed that installations have been worked out to give the engine the protection it needs against damage by sand, with the least complication and least added weight to the airplane, without upsetting the carburetor adjustments and without imposing any responsibility or added duties on the pilot. Wright Aeronautical Corporation.

To Solve Sub-Zero Starting Problems

To prepare aircraft engines for fast starting in Alaska, Iceland, Labrador, Russia and other "iceboxes" of the world, engineers of Wright Aeronautical Corporation in collaboration with research workers of the Standard Oil Company have created a polar climate in a New Jersey test cell to duplicate the sub-zero weather conditions encountered in the Arctic regions.

Beginning at zero on the Fahrenheit scale and then chilling the test cell 5° lower with each successive test, Wright engineers are using a 1,700 hp. Cyclone of the type that powers many warplanes to test new fuels, lubricants, batteries, magnetos, spark plugs and other equipment designed especially for cold weather. The aircraft engine, covered inches deep with rime ice, is operated under conditions simulating those encountered in operating warplanes from hangarless bases where temperatures of 50 to 60° below zero can congeal lubricating oil to the consistency of glue, change gasoline into a lifeless fluid and rob batteries and magnetos of voltage. Wright Aeronautical Corporation.

Plastic Material Replaces Aluminum

Wright Aeronautical engineers have worked out the replacement of two sheet aluminum parts used in the production of Cyclone aircraft engines with plastic material which saves many thousands of pounds of the vital metal monthly, more than doubles the service life of the parts involved, decreases engine weight and reduces manufacturing time and costs.

Culminating a three-year research project by the Wright company, the two parts, baffles or air deflectors, and push rod housings, were developed in cooperation with the Panelyte Division of the St. Regis Paper Company, tested on both single-cylinder and full-size engine test stands, then tested in actual flights of over 300,000 miles. The parts are now in quantity production for use as standard units on all Wright engines. Other engine manufacturers are expected to adopt the plastic parts as standard thus releasing nationally many tons of aluminum monthly for other purposes.

The parts, which are made in one instead of five manufacturing operations, are formed under applied heat and pressure in molds, with a base material such as cotton fabric, being impregnated with phenolic thermosetting resin. Made of this type of compound, the two new plastic parts are free of any critical material.

The baffles are used to deflect the air stream so that it will flow over and cool the entire surface of the cylinders. Without baffles, the air would tend to cool the front surface only. On double-row engines such as the Cyclone 14 and Cyclone 18, the baffles provide the rear bank cylinders with the same volume of air that flows over the front row. Since there are 42 of these deflectors on a 14-cylinder engine, the 25 per cent saving in weight afforded by the plastic becomes increasingly important.

The push rod housings are tubes about 12 in. long and 1 in. in diameter, which cover and protect the push rods which extend from the cams in the crankcase to the valve assemblies in the cylinder head. The housings are also a return channel for oil carried to the entire valve mechanism. The savings in aluminum are reflected by the fact that there are 28 of these push rod housings on each 14-cylinder Cyclone. Wright Aeronautical Corporation.

Institute News

New Corporate Members

The following companies have recently become affiliated with the Institute as Corporate Members:

American Tube Bending Company, Inc., specializes in the production of parts for airplanes and aircraft engines, manufactured in accordance with the customer's designs and specifications. These products are made from a wide variety of materials, including carbon, stainless and chrome steel, aluminum, brass and copper. These are bent, welded, beaded, swaged, flanged and detail-fitted. The company has recently increased its output by about 136 per cent.

Beech Aircraft Corporation is the successor of a business founded in 1932 specializing in the design and production of light aircraft. Until early in 1939, all of its business was commercial, consisting of sales to air lines, charter and photographic operators, business firms and private owners. In recent years the corporation has concentrated on large-scale production of airplanes for the United States Army Air Forces and the Navy Bureau of Aeronautics. The company has expanded its facilities and personnel substantially and has also developed an extensive subcontracting program through which numerous other concerns are engaged in the production of various parts and other equipment for its aircraft.

General Aviation Equipment Company is manufacturing more than 200 different structural parts for military and civilian aircraft. These parts are being made for several of the leading aircraft manufacturers, for the Army Air Forces and for the Navy Bureau of Aeronautics.

Kellett Autogiro Corporation has been engaged in the manufacture and development of the autogiro type of aircraft since 1929. It has been active for many months in the development of experimental autogiros, but no information is available concerning these because of restrictions on information of this type. During 1940 and 1941 a large part of its productive capacity was devoted to subcontract work for other aircraft manufacturers, consisting of the production of miscellaneous parts for these manufacturers. Production facilities have been expanded substantially to handle increased volume of business.

Pioneer Parachute Company, Inc., manufactures standard Army and Navy types of parachutes and also produces a parachute of its own development. In cooperation with the du Pont company and Cheney Brothers, the company in 1941 succeeded in producing a nylon fabric having the characteristics ordinarily found in parachute silk. Production facilities were rapidly expanded during 1941. As a part of its research work the company developed and constructed a tower for testing parachutes which has been instrumental in effecting numerous improvements in parachute design and packing methods.

Republic Aviation Corporation has greatly expanded its facilities and personnel in the past year or so. It has been fully devoted to war production, its major contribution being single-engined fighter aircraft for the Army. The latest of these is the P-47, known as the Thunderbolt. Although information on the Thunderbolt is restricted, the plane is credited with being one of the most heavily armed and armored fighters so far produced. It is said to operate efficiently at extremely high altitudes, where it has the advantage of great speed and maneuverability. Other products of Republic Aviation in recent years have been the Army P-43 Lancer and the P-35-A.

Switlik Parachute Company is a partnership that succeeded the former Switlik Parachute & Equipment Company, a corporation. Its products consist of parachutes and related parts, instrument bags, and miscellaneous canvas and leather goods.

The Warren McArthur Corporation designs, engineers and manufactures aircraft seating of all types, including pilot's, copilot's, navigator's, radio operator's, gunner's, camera operator's, bombardier's, wardroom, observation and transport seats. More than 70 designs have been developed to meet all aircraft requirements. These have been adapted as regulation equipment by Curtiss-Wright, Martin, Douglas, North American, Lockheed, Boeing, Brewster, Fairchild, Consolidated, Northrop, Vought-Sikorsky, Vega, Goodyear, Chrysler, Hudson, Bell, G & A and Fisher.

Wright Brothers' Lecture

Edmund T. Allen, F.I.Ae.S., Director of Flight and Aerodynamics at the Boeing Aircraft Company, has been chosen to deliver the sixth Wright Brothers' Lecture on December 17, 1942, at 8:30 p.m. in the Pupin Physics Laboratory, Columbia University, New York. The lecture commemorates the anniversary of the first airplane flights made by Orville and Wilbur Wright at Kitty Hawk in 1903. It is endowed by the Vernon Lynch Fund. Mr. Allen's subject will be "Flight Testing of Performance, Stability and Controllability." A dinner in his honor will be held before the lecture on the same evening at the Columbia University Faculty Club.

Mr. Allen was educated at the University of Illinois, the Massachusetts Institute of Technology and the University of Utah. In 1917 he was commissioned a First Lieutenant in the Aviation Section of the Signal Corps and served as a pilot instructor at Scott Field, later being transferred to Martlesham Heath, England. After the war he became the first test pilot for the National Advisory Committee for Aeronautics at Langley Field.

From 1920 to 1931 he was active at Massachusetts Institute of Technology, where he built and flew gliders; was engaged in the aeronautical publishing business and as a test pilot and air-mail pilot at McCook Field, for United Air Lines, Boeing Aircraft Company and Northrop Aircraft, Inc. From 1932 to the present, he has been consulting engineer and test pilot for several large aircraft manufacturers. He was the first recipient of the Chanute Award of the Institute of the Aeronautical Sciences and has made substantial contributions to the aeronautical engineering field.

John K. Northrop

Vladimir H. Pavlecka

Peter F. Rossman

Institute Members Win Lincoln Welding Foundation Awards

Members of the Institute of the Aeronautical Sciences were among the winners of awards in the competition sponsored by the James F. Lincoln Arc Welding Foundation. This program for the scientific study of welding has occupied a period of two and one-half years and is known as the "$2,000 Industrial Progress Award Program." It brought forth reports prepared by executives, engineers, designers, architects, production officials and others with reference to progress made in industrial welding. The results indicated that important savings in costs and time can be secured in the production of materials for war and peace by arc welding.

An award of $3,700 was made jointly to John K. Northrop, President, and Vladimir H. Pavlecka, Chief of Research, of Northrop Aircraft, Inc. The subject of their paper was the arc welding of magnesium alloys.

A prize of $1,500 was awarded to Peter F. Rossmann, Chief of Miscellaneous Developments Research, Airplane Division, Curtiss-Wright Corporation. His paper was devoted to a comparative study of torch and arc welding under conditions prevailing in the shop. The comparison covers quality, speed and cost and indicates a marked superiority for arc welding in all three of these categories.

Paul Ffield was the recipient of a $500 divisional award in the Functional Machinery classification for a paper on prime movers. He is a Materials Engineer with Bethlehem Steel Company, Shipbuilding Division, and is an Associate Fellow of the Institute.

Sections and Branches

Detroit Section

The first meeting of the season for the Detroit Section of the Institute was held at the Engineering Society's Building on Wednesday, October 7. The meeting was preceded by a dinner.

The principal paper at the technical meeting was "Air Cargo Problems," by Paul E. Burbank, Development Engineer, and Russell LeBrock, Manager of Cargo Service, Mail and Freight Department, United Air Lines.

The next meeting of the Section will be held in November at which time a new Chairman will be elected to replace Ralph H. Upson, who left the Detroit region last year.

Academy of Aeronautics

The Student Branch Scholastic Award was presented to Paul Dancik at the commencement exercises of the first graduating class of the Aircraft Design course in the Terrace Room of the Municipal Building, La Guardia Airport, on September 18. Oscar Williams received the Student Branch Lecture Award for the best paper of the term, "Comparison of the Rolls-Royce Merlin and Allison V-1710 Engines." The initiation for new members was scheduled to take place on October 10.

Aeronautical University

Movies from the Army Air Corps describing several Japanese and German warplanes were shown at a meeting on October 6. At a special session on October 8, Mr. Sims, Dean of Engineering, spoke to the members concerning the Midwest Student Branch Regional Meeting and the prospects of its being held in Chicago. Mr. Bedrosian, a member of the faculty and formerly an employee at a west coast aircraft plant, spoke on the value of membership in the Institute to those in the aircraft industry.

Casey Jones School of Aeronautics

On September 3 the following officers were elected for the coming term: Chairman—Paul Gravelle; Vice-Chairman—Theodore W. Meyn; Secretary—Walter Engert; Treasurer—Martin Ginsburg; Sergeant-at-Arms—Anthony DePalma; and Corresponding Secretary—Marshall Golden. That same evening the annual banquet was held at which Col. George Vaughn, Vice-President of the school, presented the new members with their Institute Emblems.

University of Detroit

Mr. James Rice, Chairman, opened the first meeting of the season of the University of Detroit Student Branch on September 24 with an address of welcome to the new and prospective members and an outline of the evening's program. He then introduced

Mr. George H. Tweney, the faculty adviser and chief speaker of the evening. Mr. Tweney spoke on the new airplanes that are already in service or will shortly come into service. He then gave a short résumé of the history of the Institute. He pointed out that it wields a potent influence in industry today, only ten years after its establishment. After a showing of the color film *Firepower of the Bell Airacobra* the meeting was adjourned.

Indiana Technical College

The following officers were elected for the Fall and Winter terms of 1942–1943 at a special meeting on September 14: Chairman—Joseph N. Kosinski; Vice-Chairman—L. J. Pursiful; Secretary—Thomas E. Millard; and Treasurer—Stanley Racisz. At a meeting on September 28 Mr. Wendell Lowry was introduced to the group as the instructor replacing Professor Hailstones, the Honorary Chairman, who has since been called away to another position.

A plan by which a school library would be started by members of the I.Ae.S. in cooperation with the members of the A.S.M.E. was announced. Chairman Kosinski explained the advantages of the services offered by The Paul Kollsman Library and urged all members of the Institute to enroll.

Mr. Clarence Forrest was appointed Chairman of the Film Procurement Committee and then delivered his paper on "Parachutes." Mr. Roy Flanigan then presented a paper on "Overloading Fighter Aircraft." Messrs. Joe D'Allura and Albert Pongraz were appointed to read papers at the meeting on October 12, after which the meeting was adjourned.

Iowa State College

At a meeting on September 30 the film *Wings of the Army*, a picture produced by the United States Army Ordnance Department, was shown. It was followed by a business meeting at which Reece Stuart was elected Senior Representative to the Engineering Council and Graydon Peoples, the Junior Representative. Membership cards were distributed and Secretary Tower made a brief explanation of the activities and privileges of membership in the Institute.

Tri-State College

At the first meeting of the Fall term of 1942, held on October 1 and presided over by Donald Christophersen, vice-chairman of the previous semester, the following officers were elected for the ensuing term: Chairman—Don Christophersen; Vice-Chairman—Wayne Hindeman; Secretary-Treasurer—Dick Leslie; Senior Student Council Representative—Kenneth Miller; and Junior Student Council Representative—Bill Wade.

The Student Council Representative, Warren Pennington, announced that the old Student Council had been disbanded and a new and more active one established. A paper known as *The Tri-State Bulletin* has been organized. After these announcements Kenneth Miller was elected to represent the societies in the Student Council.

The chairman announced that the books of The Paul Kollsman Library are available free of charge to every member. The chairman also encouraged the members to pursue any field in which they might be interested and inform the society of this particular subject with a view toward the preparation by that member of a paper to be placed in competition in the next I.Ae.S. conference.

The second meeting was held in the college auditorium, October 8, 1942, at 7:00 p.m., 250 members being present. Cowling models, designed after the type of cowling designed and presented by Don Christophersen at the last conference held at Notre Dame were announced as available for anybody desiring to run wind-tunnel tests on them in order to obtain data for a paper to be presented at the next Student Branch Regional meeting.

The business meeting was then adjourned. The technicolor sound film on the Bell Airacobra was shown.

University of Oklahoma

Preceding the meeting the technicolor film, *Cannon on Wings*, was shown to an audience of pre-engineering freshmen and engineering students. The business meeting was then called to order by Paul Browne, Vice-Chairman. Since the Chairman, Don Malvern, had joined the U.S. Army, Mr. Browne was elected Chairman and W. S. Liebermann was elected Vice-Chairman. Mr. Foster was appointed Chairman of the Committee to plan a "smoker" which was to be followed by a round-table discussion on Curtiss-Wright airplanes to be led by Mr. Baker, who had worked for Curtiss-Wright during the Summer.

News of I.Ae.S. Members

Bernard S. Adams, meteorologist with Panair do Brasil, S.A., has been appointed meteorologist in charge at the Natal Section office of that air-line system.

Harold F. Allen has been commissioned a Lieutenant, A-V (T), U.S.N.R.

Louis E. Barnes has been appointed a Power-Plant Engineer at Fisher Memphis Aircraft Division of General Motors Corporation.

Clarence M. Belinn, M.I.Ae.S., formerly Vice-President and General Manager of Kansas City Southern Airlines and later Director of the Division of Air Transport of Matson Navigation Company, San Francisco, has been elected Vice-President of Hawaiian Airlines, Ltd., at Honolulu, T.H.

John T. Bennett, an engineer with Northrop Aircraft, Inc., is engaged as a detailer in the Wing Group.

Nelms Black, former Associate Editor of the REVIEW, has joined the staff of Goodyear Aircraft Corporation.

Donald L. Bower, M.I.Ae.S., has been promoted to the rank of Captain in the Army Air Forces.

Max J. Breitenbach has been transferred to the structures group at Consolidated Aircraft where he is Junior Stress Analyst.

Robert Brown has been promoted to the rank of Captain in the South African Air Forces.

Charles O. Cary is now a Pilot Instructor at the Pilot Training School of American Airlines.

Ernest G. Chilton, formerly an instructor at the Aeronautical University, Inc., has taken up his new duties as Assistant Professor of Aeronautics at the University of Akron.

Harold B. Crockett has advanced from Junior Stress Engineer to Aerodynamics Research Engineer at Lockheed Aircraft Corporation.

Walter M. Davies, formerly with the Globe Aircraft Corporation, has joined the Airplane Division of Curtiss-Wright Corporation as an Aeronautical Layout Draftsman.

Walton H. Decker, formerly Weight Engineer with North American Aviation, Inc., has received his commission as a Lieutenant in the Army Air Forces and has been assigned to the Experimental Engineering Section at the A.A.F. Matériel Center.

E. J. Demas, who was until recently Supervisor of Structural Testing at Lockheed Aircraft Corporation, has joined the Intercontinental Division of Transcontinental & Western Air, Inc., as flight engineer.

Carl F. Eck has been appointed 2nd Officer (pilot) with the Intercontinental Division of Transcontinental & Western Air, Inc. He was formerly with the Engineering Department of The Glenn L. Martin Company.

Frampton E. Ellis, formerly instructor at Aeronautical University, Inc., has been commissioned a Lieutenant in the United States Naval Reserve and assigned to active duty as Assistant Flight Test Officer at an East Coast Naval Air Station.

A. H. Roy Fedden, Hon.F.I.Ae.S., Chief Engineer of Bristol Aeroplane Co. Ltd., of England, has been knighted by King George as Sir Roy Fedden.

Lewis Feldman is now engaged in research work at the Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics. He was formerly with the Engineering and Research Corporation.

James Ford, formerly Secretary to the Director of Engineering, Curtiss-Wright Corporation, is now Assistant to Deputy Director of Aircraft Production of the War Production Board.

Robert E. Fowler, M.I.Ae.S., who was formerly Public Relations Director, Air Associates, Inc., has received his commission as a Lieutenant (j.g.) in the United States Coast Guard.

Frederick S. Frank, licensed flight and ground instructor, is Secretary-Treasurer of the S & M Flying Service.

Michael H. Froelich, M.I.Ae.S., formerly Associate Editor of the magazine *Aero Digest*, has been appointed Managing Editor.

Herman Gahm resigned recently as an instructor at the Casey Jones School of Aeronautics and has joined Fairchild Aircraft Division, Fairchild Engine & Airplane Corporation, as a Stress Engineer.

Armand J. Gariepy, M.I.Ae.S., Director of Insurance for United States Aviation Underwriters, Inc., is now with Defense Supplies Corporation in Washington.

Valerian N. Gartseff, M.I.Ae.S., who for the past five years has been a member of the engineering staff of The Glenn L. Martin Company, is now in charge of the Stress Department at Eastern Aircraft Division, General Motors Corporation.

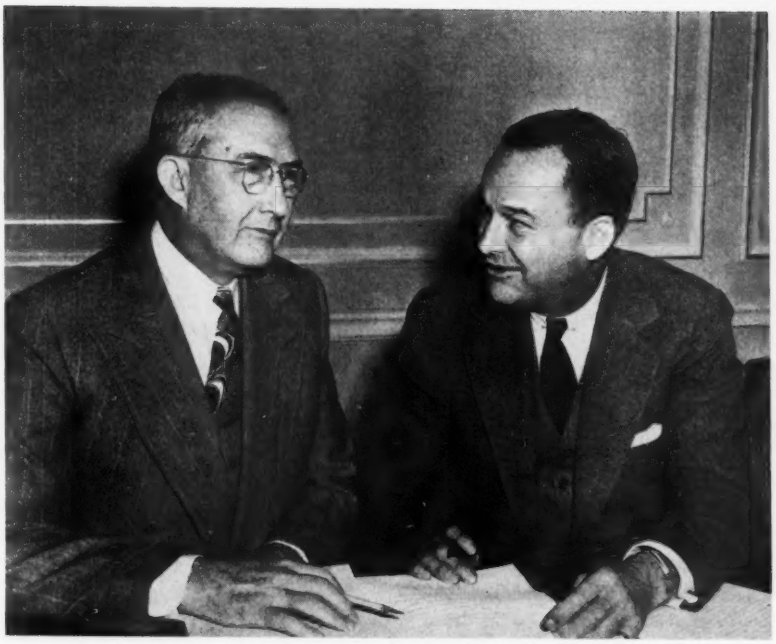
Reginald E. Gillmor, A.F.I.Ae.S., President of Sperry Gyroscope Company, Inc., has been elected to the Executive Committee of Fairchild Engine & Airplane Corporation.

Gerald Goertzel is now an Instructor in Aeronautical Engineering at New York University. He was formerly a Research Engineer at Republic Aviation Corporation.

Karl F. W. Goettert has resigned as a draftsman at Bristol Aeronautical Corporation and has joined Douglas Aircraft Company, Inc., in a similar capacity.

James R. Graham has been named National Production Manager of United States Aviation Underwriters, Inc., and will also supervise the Chicago territory of which he has been in charge.

Max E. Hartley has been appointed Field Service Engineer of the Boeing Aircraft Company.



Glenn L. Martin, (left), President of The Glenn L. Martin Company and Vice-President of the newly organized Aircraft War Production Council, East Coast, Inc.; and G. W. Vaughan (left), President of Curtiss-Wright Corporation, and head of the new Council.

Thomas L. Heid has joined Consolidated Aircraft Corporation as a Stress Analyst. He was formerly engaged in a similar capacity with The Glenn L. Martin Company.

Anthony J. Harold, formerly Chief of Stress and Design Engineer at Bendix Aviation, Ltd., in California, is at present Associate Aeronautical Engineer with the Army Air Forces Matériel Center.

Jerome Hoffer, Jr., has been appointed an Instructor in Aeronautical Engineering at Duke University.

William V. Humphrey, formerly on the staff of the Institute, is now office manager at the Southington Plant of Pratt & Whitney Division, United Aircraft Corporation.

Donald C. Hunt, Engineer, Aircraft Development Section, General Motors Corporation, is also an Instructor in Aeronautics at Lawrence Institute of Technology and Detroit Institute of Technology. He was formerly Assistant Managing Secretary of the Engineering Society, Detroit.

Milton Jakosky, A.F.I.Ae.S., has left the C.A.A., in which he was Chief, Aircraft Engineering Branch, to go on active duty as a Major in the U.S. Army Air Forces.

Philip O. Johnson has joined Fisher Body Aircraft Unit, General Motors Corporation, as Senior Stress Engineer. He was formerly an Aeronautical Instructor at California Polytechnic School.

Walter C. Johnson, who graduated from the Boeing School of Aeronautics in May, has been appointed Meteorologist, United Air Lines Transport Corporation.

B. Melvill Jones, H.F.I.Ae.S., F.R.Ae.S., Francis Mond Professor of Aeronautical Engineering at Cambridge University, England, has been knighted and is now known as Sir B. Melvill Jones.

Assen Jordanoff, M.I.Ae.S., aviation writer, is President of the recently formed Jordanoff Aviation Company.

William C. Jungemann, Stress Analyst with Consolidated Aircraft Corporation, has been transferred to the Company's Fort Worth Division.

Felix Kallis, M.I.Ae.S., resigned as Chief Aeronautical Engineer of the Assembly and Repair Department, an east coast Naval Air Station, and has joined Bell Aircraft Corporation in the capacity of Chief of Engineering Planning.

Gerald G. Kayten has won promotion from the grade of Junior Aeronautical Engineer to Assistant Aeronautical Engineer at the Langley Memorial Aeronautical Laboratory.

William H. Klenke, Jr., M.I.Ae.S., has resigned as Assistant Sales Manager of Vultee Aircraft, Inc., and has been assigned to active duty with the rank of Major in the United States Marine Reserve Corps as Commanding Officer of Aircraft Engineering Squadron 24. Formerly a Captain in the Marine Reserve, he is now doing active flying duty.

On leave for the duration from American Export Airlines, **Philip G. Kraushar** has received his commission as a 2nd Lieu-

A LIFESAVER for the aircraft mechanic

Note the switching device which automatically grounds the magneto when fittings are disconnected.

This dual magneto grounding plug guards the lives of the ground crew mechanics as they swarm over a plane during service and repair operations. Without such a safety device, any movement of the propeller might accidentally start the engine with tragic results.

With this Cannon Plug it is not necessary for anyone to remember to ground the magneto after the engine circuits have been disconnected for servicing. This is a typical example of how Cannon Plugs are used for a wide variety of applications in aircraft and other fields.

CANNON SERVES MANY INDUSTRIES

Cannon precision-type multi-contact connectors are made in countless shapes, sizes and styles, and are backed by twenty-seven years of electrical specialty manufacturing experience. They have become standard equipment in radio, television, aircraft, motion pictures and countless other fields.

CANNON ELECTRIC

CANNON ELECTRIC

Cannon Electric Development Company, Los Angeles, Calif.

Canadian Factory and Engineering Office: Cannon Electric Company, Limited, Toronto, Canada

tenant, Army Air Forces (Weather Section). He was formerly Senior Meteorologist, Northeast Airlines.

Designation of the new position held by **Jerome Lederer,** A.F.I.Ae.S., is Deputy Director of the Airlines War Training Institute, the cooperative organization administering the training program for contractors for the A.A.F. Transport Command.

William A. Leuang, formerly Stress Analyst with The Glenn L. Martin Company, has taken up new duties as Stress Engineer with Eastern Aircraft Division of General Motors Corporation.

Harold C. Martin, M.I.Ae.S., entered upon new duties as Instructor in Aeronautical Engineering at Princeton University this Fall, having resigned a similar position at New York University.

Frank S. Mayer, formerly a Detail Draftsman, has been promoted to Junior Stress Analyst at Consolidated Aircraft Corporation, Fort Worth Division.

George F. McLaughlin, M.I.Ae.S., who had been editor of *Aero Digest*, since 1929, has recently left the magazine to become Executive Director of Production at Jordanoff Aviation Company.

Brig. Gen. Clements McMullen, A.F.I.Ae.S., has been made Assistant Chief, Air Service Command, U.S. Army Air Forces, Washington, D.C.

Edward J. Minser, M.I.Ae.S., who was formerly Chief Meteorologist at Transcontinental & Western Air, Inc., has been transferred to head the TWA Intercontinental Division.

Montgomery W. Pope has received his commission as Lieutenant (j.g.), U.S.N.R, and is on active duty at the Navy Bureau of Aeronautics, Structures Section. He was formerly Assistant Chief Engineer, Duramold Aircraft Corporation Division, Fairchild Engine & Airplane Corporation.

Stanford E. Neice has been appointed Junior Engineer with the National Advisory Committee for Aeronautics, Langley Memorial Aeronautical Laboratory.

Robert A. Nova has recently joined with Sperry Gyroscope Company, Inc., as a Service Engineer in the Aircraft Fire Control Section.

Albert M. Patterson, M.I.Ae.S., on leave of absence as President of the Aeronautical Manufacturing Corporation, has been commissioned a 2nd Lieutenant in the U.S. Army Air Forces and has been ordered to duty at an East Coast Sub-Depot as Assistant Engineering Officer.

Alexander S. Poskus, formerly Stress Analyst with the Airplane Division, Curtiss-Wright Corporation, has been commissioned an Ensign in the U.S. Naval Reserve.

Carl N. Sanford, M.I.Ae.S., until recently Assistant Professor of Aeronautical Engineering at North Carolina State Col-

lege, has taken a new assignment as Engineer at Boeing Aircraft Company.

Norbert C. Schnaubelt has been promoted from Inspector to Junior Stress Analyst at Consolidated Aircraft Corporation, Fort Worth Division.

J. Howard Self has joined Interstate Aviation and Engineering Corporation. Until recently he was with Hughes Aircraft Company.

John W. Sharp M.I.Ae.S., arrived recently in London to take up his duties as Engineering Service Representative for the United Kingdom for the Douglas Aircraft Company, Inc.

Max Sokol has joined the War Production Division of the H. J. Heinz Company. He was formerly Aeronautical Engineer at Brewster Aeronautical Corp.

Herman R. Sussman was recently appointed Instructor in Structures, at an Air Force Technical School. He was formerly engaged as shop instructor at Sewanhaka High School, Floral Park, N.Y.

Wilson L. Sutton, A.F.I.Ae.S., who has been with Grumman Aircraft Engineering Corporation since April, has been made a Plant Manager. He was previously with Brewster Aeronautical and prior to that was Vice-President and Chief Engineer of Fleetwings, Inc.

Lee A. Telesco has received his commission as 2nd Lieutenant, United States Army Air Forces, having completed his training as an Aviation Cadet.

Charles F. Thomas, M.I.Ae.S., was recently promoted to be Manager of the Contract Department of Lockheed Aircraft Corporation. He was formerly in charge of the Dayton office of the corporation.

George I. Toumanoff has joined Lockheed Aircraft Corporation as Wind Tunnel Test Engineer. He was formerly Research Assistant at Massachusetts Institute of Technology.

James H. Voyles, Jr., having completed training as a Student Pilot in June, has now received his commission as a 2nd Lieutenant, U.S. Army Air Forces, and has been assigned to an Army Air Forces Basic Flying School.

Walter C. Walling has been promoted to Senior Research Assistant at Lockheed Aircraft Corporation.

Edwin C. Walton, M.I.Ae.S., has taken up his new duties as Project Engineer—Heavy Bombers, Aircraft Branch of the War Production Board at Washington. He was formerly a sales engineer in the Export Sales Division of Curtiss-Wright Corporation in New York City.

John A. Wright has been reassigned from his work as Structures Engineer with The Glenn L. Martin-Nebraska Company to be Assistant Project Engineer with The Glenn L. Martin Company.

Members Elected

The following applicants for membership or applicants for change of previous grade have been admitted to membership in the grades indicated since the publication of the list in the last issue of the Review.

Transferred to Associate Fellow Grade

Locke, Arthur A., M.E.; Assoc. Prof. and Head, Dept. of Aero. Engineering, Wayne Univ.

Parkinson, Leslie Rendall, B.S. in M.E.; Assoc. Prof. and Head, Dept. of Aero. Engineering, North Carolina State College.

Semion, Walter Alexis, B.S.; Asst. Chief Engineer, Aircraft War Production Div., H. J. Heinz Co.

Thornbury, Paul Cobb, Chief Test Pilot, North American Aviation, Inc.

Elected to MEMBER Grade

Allen, James Ross, M.S.; Capt., U.S.N.; Chief Engineer, Naval Aircraft Factory.

Brie, Reginald Alfred Charles, Wing Commander, R.A.F.; British Air Commission.

Coan, John M., Jr., M.E.; Asst. Prof., Aero. Engineering, Iowa State College.

Donovan, Allen Francis, M.S. in Ae.E.; Research Engineer, Research Laboratory, Curtiss-Wright Corp.

Godfrey, Walter, B.S. in E.E.; Landing Gear & Controls Group Leader, Aviation Div., Snead & Co.

Grant, David Norvell Walker, M.D.; Brig. Gen., U.S. Army (M.C.); Air Surgeon, Army Air Forces.

Horn, Helmer Tory, B.S. in E.E.; Asst. Chief Service Engineer, Boeing Aircraft Co.

Lane, Paul Stoner, Research Engineer, Muskegon Piston Ring Co.

Maser, Ernest Eberhard, M.S.; Asst. Prof., Aero. Engineering, College of Engineering, Louisiana State Univ.

Mooney, Albert William, Vice-Pres. & Chief Engineer, Culver Aircraft Corp.

Nebesar, Robert John, B.S. in Ae.E.; Vice-Pres. & Chief Engineer, Bristol Aircraft Div., Universal Moulded Products Corp.

Newton, Gaylord Weld, B.S. in M.E.; Asst. Chief Power Plant Engineer, Boeing Aircraft Co.

Plesset, Milton Spinoza, Ph.D.; Aerodynamicist, Douglas Aircraft Co., Inc.

Ribner, Hebert Spencer, Ph.D.; Asst. Physicist, Langley Mem. Aero. Lab., N.A.C.A.

Schofield, Edward B., B.S. in M.E.; Product Engineer, Sperry Gyroscope Co., Inc.

Webster, Sidney Haskins, B.M.E.; Chief, Technical Data Section, Eclipse Aviation Div., Bendix Aviation Corp.

Transferred to MEMBER Grade

Goring, Gilman Rogers, B.M.E.; Squadron Leader, Chief Technical Officer, R.C.A.F., Canada.

Thomas, Harold William, B.S. in M.E.; Test Pilot, Airplane Div., Curtiss-Wright Corp.

Elected to Industrial Member Grade

Bree, Albert, Mold Loft Supervisor, Brewster Aeronautical Corp.

Joseph, Franklin Hempy, B.S. in M.E.; Asst. to Vice-Pres. for Sales, Sperry Gyroscope Co., Inc.

Palmer, John Roger, Manager of Contracts, Chicago Pneumatic Tool Co.

Spencer, Leslie Vanderford, M.E.; Editor, *Aero Digest.*

Elected to Technical Member Grade

Audet, Clement Richard, B.S. in M.E.; Jr. Aero. Engineer, Materiel Center, Army Air Forces, War Dept.

Beineman, Charles Henry, B.S. in Ae.E.; Jr. Aero. Engineer, Materiel Center, Army Air Forces, War Dept.

Bissinger, Barnard Hinkle, M.A.; Instructor in Math., Cornell Univ.

Broadhead, Paul Smith, B.S. in M.E.; Test Engineer, Airplane Div., Curtiss-Wright Corp.

Burghardt, Joseph Endler, M.E.; Sr. Hydrodynamicist, The Glenn L. Martin Co.

Chow, Lewis, B.S. in Ae.E.; Design Draftsman, Noorduyn Aviation Ltd., Canada.

Collins, Carvel Emerson, M.A.; Lt. (j.g.), U.S. Naval Reserve.

Crofut, Edward G., Research Asst., California Inst. of Technology.

Goran, Lenard Abraham, B.S. in M.E.; Structures Engineer, Airplane Div., Curtiss-Wright Corp.

Hamilton, Sam R., B.S.; Ground School Director, North Aviation Co.

Helweg, Paul Frederiksen, Liaison Engineer-Experimental, Vought-Sikorsky Aircraft Div., United Aircraft Corp.

Hofweber, August John, Jr., B.M.E.; Asst. Supervisor, Engineering Standards Dept., Fisher Memphis Aircraft Div., General Motors Corp.

Kuns, Harold J., Ae.E.; Stress Analyst, Waco Aircraft Co.

Miller, Herbert Hutchison, Chief Draftsman, Noorduyn Aviation Ltd., Canada.

Northrup, John Laurence, B.S. in Ae.; Stress Analyst, Goodyear Aircraft Corp.

Ocvirk, Fred William, M.S. in C.E.

Instructor in Aircraft Structures, Cornell Univ.

Pomerantz, Herbert Bearl, M.A.; Asst. to Planning & Scheduling Engineer, Douglas Aircraft Co., Inc.

Scolaro, Dominick Raphael, Tool Engineer, Brewster Aeronautical Corp.

Smith, Lester William, Jr., Stress Analyst, Aero. Div., Snead & Co.

Smith, Roy Valentine, B.Ae.E.; Instructor in Aero. Engineering, Rensselaer Polytechnic Inst.

Sturm, Fred William, Jr. Aero. Layout Draftsman, Andover Kent Aviation Corp.

Turner, Kenneth Bertrand, M.E.; Engineer, Bristol Aircraft Div., Universal Moulded Products Corp.

Yates, Edward Axel, B.S. in E.; Lt., U.S.N.R.; Bureau of Aeronautics, Navy Dept.

Transferred from Student to Technical Member Grade

Brown, William Edward, M.S. in Ae.E.; Stress Analyst, Airplane Div., Curtiss-Wright Corp.

Ceccarelli, John Fortunato, B.S. in Ae.E; Design Engineer, The Glenn L. Martin Co.

Cosner, Norman Don, B.S. in Ae.E.; Stress Analyst, Meyers Aircraft Co.

Culver, Charles Asa, Sr. Detail Draftsman, North American Aviation Inc.

Eldridge, Robert Arnold, B.S. in M.E.; Stress Engineer, Douglas Aircraft Co., Inc.

McDonough, Charles Francis, B.Ae.E.; Power Plant Engineer, McDonnell Aircraft Corp.

Peterson, James G., B.Ae.E.; 2nd Lt., U.S. Army Air Forces.

Elected to Affiliate Grade

Day, Alfred Lewis, Supervising Inspector, Materiel Command, Army Air Forces, War Dept.

Hoff, William Charles, Aviation Editor, William H. Wise & Co.

Ricker, Chester S., M.E.; Detroit Field Editor, *Wings.*

Stetson, Lee Clark, B.A.; Loftsman, Vought-Sikorsky Aircraft Div., United Aircraft Corp.

Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Chief Draftsman, 5 to 10 years' experience in mechanical products. Background in lining up drafting assignments, records, engineering reference material, coordination of blueprinting with production, etc. Experience in training methods in developing new drafting personnel helpful. Write or apply personally. Personnel Dept. (7th Floor), Simmonds Aerocessories, Inc., 21–10 Forty-ninth Avenue, Long Island City, N.Y.

Layout Men and Stress Analysts, three to four years' aircraft experience essential, wanted by established eastern aircraft concern. Address inquiries to G & A Aircraft, Inc., Pitcairn Field, Willow Grove, Pa.

Airplane Operations Analyst for work in connection with (1) the preliminary design of military and commercial cargo and passenger transport airplanes, and (2) the military operation of current-production cargo planes. Aeronautical engineering training and air-line operations training or experience are desirable. Persons applying for this position should be qualified to work independently on the analysis of transport air-line operation efficiency and operating cost. Address inquiries to Box 173, Institute of the Aeronautical Sciences.

Executive Assistant. Capable man with management experience to act as Assistant to the President. Inquiries will be held strictly confidential and should be made to the Office Manager, McDonnell Aircraft Corp., St. Louis.

Sales Manager. Must have considerable sales and aircraft experience. Please give qualifications, references and salary desired. Inquiries will be held strictly confidential and should be made to the Office Manager, McDonnell Aircraft Corp., St. Louis.

Stress Analysts wanted by a large, well-known manufacturer of high-speed military aircraft, situated in Indiana. Only men with at least two years' experience who are not now employed in defense work or who can secure a release from their present employer need apply. Make application in writing, giving all particulars, and send to Box 170, Institute of the Aeronautical Sciences.

Metallurgist to take complete charge of Materials Laboratory with leading aircraft engine manufacturer. Must be familiar with modern heat-treat methods. Mid-west location. No applications sought from persons employed in war production work except with approval of present employers. Address inquiries to Box 169, Institute of the Aeronautical Sciences.

Test Pilot wanted by leading aircraft engine manufacturer in East. Must be capable of operating 1,000 hp., single-engined airplane. Engineering background desirable but not necessarily required. No applications sought from persons employed in war work except with approval of present employers. Address inquiries to Box 168, Institute of the Aeronautical Sciences.

A Midwestern University has a vacancy on the regular teaching staff of the Department of Aeronautical Engineering. Applicants should have teaching, research, or industrial experience. Rank and salary will be determined on the basis of applicant's qualifications. This would not be a "duration" appointment. Address inquiries to Box 167, Institute of the Aeronautical Sciences.

Instructor or Assistant Professor for Airplane Design, Stress Analysis and Modern Aircraft Structural Theory in order to fill existing vacancy in regular staff of Aeronautical Engineering Department at College Station. Must have degree in Aeronautical Engineering and practical experience in industry. Ample opportunity and encouragement are provided for research, as well as industrial contacts with the rapidly expanding aircraft industry in Texas. Rank and salary will depend upon qualifications. Applicants now employed in defense industry must obtain release by present employer before being accepted. Letter of application should include snapshot and photo together with personal data, educational background, and practical experience record in detail. Address replies to H. W. Barlow, Texas A. & M., College Station, Tex.

The Army Air Forces has urgent need for personnel with an aircraft engineering and maintenance background. The prime function of this personnel will be the coordinating of Army Air Forces contractor efforts in the Central States in supplying maintenance data, maintenance parts and maintenance tools as contracted. Approximately three-fourths of the time of this personnel will be spent in the field. Interested applicants should file qualification briefs with the District Supervisor, Central Procurement District, A.A.F. Materiel Center, 8505 West Warren Avenue, Detroit, Michigan, marked Attention: District Air Service Command Liaison Officer.

Airplane Stress Analysts, Checkers and Draftsmen needed to complete our engineering staff. Two to four years' experience in aeronautical work required. Write for appointment stating education, experience, and salary. Snead & Company, Aeronautical Division, 421 Canal Street, New York.

Draftsman, preferably with instrument experience, for work on con-

fidential projects for Army and Navy having vital bearing on the war effort. Applicants must be able to satisfy F.B.I. regarding citizenship and loyalty prior to starting work. Residence and work will be in small town on Long Island. It is anticipated work will be permanent. Address inquiries to Box 157, Institute of the Aeronautical Sciences.

Engineering Instructors wanted by approved school in Midwest. Furnish qualifications, experience and snapshot in first letter. Address inquiries to Box 152, Institute of the Aeronautical Sciences.

AVAILABLE

Test Pilot and Flight Research Engineer, experienced, now employed, but available for short intervals of time to do additional test flying on a contract basis. Address inquiries to Box 175, Institute of the Aeronautical Sciences.

Graduate Aeronautical Engineer, sixteen years of practical experience on design, development, and project engineering. Specialist in the design of military aircraft for both Army and Navy. Has served as consulting engineer and staff engineer of many of the airplanes now used by the Services. Desires connection as staff or project engineer. Address inquiries to Box 174, Institute of the Aeronautical Sciences.

Aeronautical Engineer and Commercial Pilot desires permanent position in test flying or similar work. B.Ae.E. degree with experience in design and test work. Over 1,000 hours flying time, primary, secondary, and cross-country flight instructor's ratings and C.A.A. ground instructor's ratings in engines and navigation. Currently employed as Chief Pilot of Government contract flight training school but would prefer work in which engineering training and experience could be utilized. Address inquiries to Box 172, Institute of the Aeronautical Sciences.

Aeronautical Engineer (Ae.E.), twenty-six years' experience in the design and construction of various types of military and commercial airplanes. Thoroughly familiar with Navy procedure. Interested in administrative or executive position only. Address inquiries to Box 165, Institute of the Aeronautical Sciences.

The Technical Information Services

of the

Aeronautical Archives

of the

Institute of the Aeronautical Sciences

This service has experienced personnel under the supervision of trained aeronautical engineers to compile any information desired. The services range from listing specialized reference books to the preparation of exhaustive bibliographies, digesting of reports and general surveys of any aeronautical subject. Some of the available services are:

Bibliographies on any aeronautical subject.
Reports on any aeronautical subject.
Digests of aeronautical books, papers, periodicals and references.
Translations in all languages.
Engineering investigations of special aeronautical subjects.
Biographies of individuals engaged in aeronautics.
Photostats of any aeronautical or general engineering material.
Microfilms made on special order.
Photographs made from the Institute's photographic collection.
Drawings and tracings made.

In addition to the services mentioned any commission which comes within the scope of the Service will be accepted.

Research work is charged at the usual library fee of $2.00 per hour. Special arrangements may be made for work requiring several weeks or months.

Translators are available for accurate transcriptions of all foreign language data. Translations are carefully edited by trained engineers at the standard rate of 1c per word. Minimum charge, $2.00.

Reproductions of any material in the Aeronautical Archives of the Institute may be ordered at standard photostat rates.

Institute of the Aeronautical Sciences Membership Roster

In this alphabetical list of members of the Institute the names of those enrolled as members before the present war who are now in enemy or enemy occupied territory have been deleted, as well as those in any other countries with which communication is no longer possible, since their status cannot be determined in most cases until after the war.

As biographic data about many of the members listed here would, if published in the form used in previous Rosters, reveal information not in the public interest to disclose, a consistent form for all the entries in this Roster has been used by which only the name of the company or general organization with which each member is connected is shown. Since invitations to membership in the new grade of Affiliate have only recently been issued, none of the members in this grade are included in this list.

The abbreviations preceding each name indicate the grade of membership in the Institute as follows:

AF	Associate Fellow	HM	Honorary Member
B	Benefactor	I	Industrial Member
F	Fellow	M	MEMBER
HF	Honorary Fellow	T	Technical Member

The affiliations of members as given here are those on record with the Institute at this date. Members are requested to forward to the Secretary of the Institute in complete form any information necessary to correct their biographic records as to address, position or rank, and professional affiliation.

T **Abajian, Henry K.,** Vultee Aircraft, Inc.
I **Abbott, C. J.,** Jacobs Aircraft Engine Co.
M **Abbott, Ira H.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Abraham, Lewis H.,** Douglas Aircraft Co., Inc.
T **Acton, Stanley M.,** Airplane Div., Curtiss-Wright Corp.
T **Adamovich, George Wm.,** Pan American Airways System.
AF **Adams, Group Capt. Albert O.,** R.C.A.F., Canada.
T **Adams, Alfred A.,** Airplane Div., Curtiss-Wright Corp.
T **Adams, Barnard S.,** Panair do Brasil S.A., Brazil.
AF **Adams, Burnham,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Adams, Charles M.**
M **Adams, Harold L.,** Boeing Aircraft Co.
M **Adams, Parks M.,** The Glenn L. Martin Co.
AF **Adams, Porter H.,** Norwich Univ.
I **Adamson, Robert M.,** Shell Oil Co., Inc.
T **Adler, R. C.,** All American Aircraft Products, Inc.
T **Adrian, Joseph L.,** Propeller Div., Curtiss-Wright Corp.
M **Ahlers, John D.,** Ranger Aircraft Engines Div., Fairchild Engine & Airplane Corp.
AF **Akerman, Prof. John D.,** Univ. of Minnesota.
I **Akin, Russell B.,** E. I. du Pont de Nemours & Co.
T **Albert, George D.,** Northrop Aircraft, Inc.
T **Alberti, Paul L. E.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Aldridge, Capt. John F., Jr.,** U.S. Army Air Forces.
F **Aldrin, Col. Edwin E.,** Aeronautical Consultant.
T **Alexander, Lt. Francis B.,** U.S. Army Air Forces.
T **Alexander, John D.,** Vultee Aircraft, Inc.
T **Alexander, Sidney R.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Alexeeff, Serge A.,** Brewster Aeronautical Corp.
AF **Alfaro, Heraclio,** American Bosch Corp.
I **Allard, Lt. Col. John S.,** U.S. Army Air Forces.
F **Allen, Edmund T.,** Boeing Aircraft Co.
T **Allen, Lt. Edwin C.,** U.S. Army Air Forces.
M **Allen, Fred C.,** Douglas Aircraft Co., Inc.
AF **Allen, Hugh E.,** RCA Mfg. Co.
M **Allen, Capt. J. Ross,** U.S. Navy.
AF **Allen, Joseph W.,** Navy Dept.
T **Allen, G. Merrill,** Airplane Div., Curtiss-Wright Corp.
T **Allen, Lt. Harold F.,** U.S. Navy.
T **Allen, Warren J., Jr.,** Grumman Aircraft Eng. Corp.
T **Allison, James R.,** Eng. & Research Corp.
T **Allred, Robert W.,** Boeing Aircraft Co.
T **Allsop, A. W.,** Lockheed Aircraft Corp.
AF **Allward, George A.,** Hughes Aircraft Co.
T **Alperin, Morton,** U.S. Army Air Forces.
M **Alter, Horace J.,** Consulting Engineer.
T **Altmaier, Robert D.,** Airplane Div., Curtiss-Wright Corp.
AF **Altman, Peter,** Research Div., Aviation Mfg. Corp.
T **Altseimer, John H.,** The Glenn L. Martin Co.
T **Amanuel, Eli,** Munk Aeronautical Lab.
T **Amarante, Capt. Benjamin M.,** Brazilian Embassy.
I **Ambrose, Frank J.,** Aviation Inst. of Tech.
HF **Ames, Dr. Joseph S.,** President Emeritus, Johns Hopkins Univ.
T **Ames, Milton B., Jr.,** N.A.C.A.
T **Amico, G. Vincent,** Airplane Div., Curtiss-Wright Corp.
T **Anders, Archie,** Vega Aircraft Corp.
T **Anderson, Benjamin M.,** Boeing Aircraft Co.
T **Anderson, Joseph L.,** Ames Aero. Lab., N.A.C.A.
T **Anderson, Leon R.,** The Glenn L. Martin Co.
T **Anderson, Morris C.,** Rensselaer Polytech. Inst.
M **Anderson, Newton H.,** Douglas Aircraft Co., Inc.
AF **Anderson, Robert,** Douglas Aircraft Co., Inc.
T **Anderson, Warren G.,** Mass. Inst. of Tech.
T **Anderton, David A.,** Grumman Aircraft Eng. Corp.
AF **Andrake, Andrew A.,** The Glenn L. Martin-Nebraska Co.
M **Andrews, Edward F.,** E. F. Andrews Laboratories.
M **Andrews, James B.,** North American Aviation, Inc.
M **Andrews, Walter I.,** Boeing Aircraft Co.
AF **Angle, Glenn D.,** Angle Engineering Co.
T **Antonenko, Basil P.,** Boeing School of Aeronautics.
M **Archbold, Richard C.,** American Museum of Natural History.
T **Archer, Gerald R.,** The Glenn L. Martin Co.
T **Archer, Harry C.,** Grumman Aircraft Eng. Corp.
AF **Arcier, A. Francis,** Waco Aircraft Co.
T **Arkawy, Seymour M.,** Brewster Aeronautical Corp.
T **Armbrust, Charles M.,** The Glenn L. Martin Co.
M **Arms, John H. R.,** United Engineering Trustees, Inc.
T **Arms, Richard P.,** General Electric Co.
T **Armstrong, Alfred P.,** The Glenn L. Martin Co.

M **Armstrong, Cecil W.,** Univ. of Calif.
AF **Armstrong, Major Harry G.,** U.S. Army Medical Corps.
T **Armstrong, William,** Dowty Equipment Corp.
M **Arnhym, Albert A.,** Pacific-Airmax Corp.
HM **Arnold, Lt. Gen. Henry H.,** U.S. Army Air Forces.
T **Arnold, James E.,** Taylorcraft Aviation Corp.
AF **Arnold, Weld,** Calif. Inst. of Tech.
F **Arnstein, Dr. Karl,** Goodyear Aircraft Corp.
T **Arrigo, Vincent P.,** Airplane Div., Curtiss-Wright Corp.
M **Arslan, Albert E.,** Vultee Aircraft, Inc.
T **Ash, Howard,** Republic Aviation Corp.
T **Ashkenas, Irving L.,** North American Aviation, Inc.
M **Ashton, Benjamin N., Jr.,** Electrol, Inc.
T **Ashton, John,** Electrol, Inc.
M **Ashton, Robert,** Brooklands Aviation Ltd., England.
T **Atkinson, Lt. Robert P.,** Allison Div., General Motors Corp.
T **Atterbury, William W., Jr.,** Pan American Airways System.
F **Atwood, J. L.,** North American Aviation, Inc.
T **Audet, Clement R.,** War Dept.
T **Autry, Peyton,** Boeing Aircraft Co.
T **AuWerter, Lt. Jay P.,** U.S. Army Air Forces.
T **Avery, Harold T.,** Marchant Calculating Machine Co.
T **Avgerenos, Alexander G.,** Consolidated Aircraft Corp.
T **Awig, Howard E.,** Airplane Div., Curtiss-Wright Corp.
T **Axtell, Capt. George C., Jr.,** U.S. Marine Corps.
M **Ayer, Robert W.,** Fleetwings, Inc.
T **Ayers, W. W.,** Vega Aircraft Corp.

T **Baals, Donald D.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Babberger, Carl W.,** Hughes Aircraft Co.
M **Bache, Richard F.,** War Dept.
M **Backer, Prof. Gerald H.,** Univ. of Kentucky.
T **Baggs, George M.,** Univ. of Minnesota.
T **Bailey, Walter Ernest,** Platt-LePage Aircraft Corp.
T **Baird, Lt. Roger P., Jr.,** U.S. Army Air Forces.
F **Bairstow, Prof. Leonard,** Univ. of London, England.
T **Bajkowski, Frank W.,** Lockheed Aircraft Corp.
M **Baker, Carl F.,** Hamilton Standard Propellers Div., United Aircraft Corp.
M **Baker, George P.,** War Dept.
T **Baker, Joel R., Jr.,** Troy Fliers, Inc.
M **Baker, Max P.,** Waco Aircraft Co.
AF **Baker, Paul S.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Baker, Ralph D.,** Univ. of Utah.
AF **Bakhmeteff, Prof. Boris A.,** Columbia Univ.
T **Ball, J. Norman,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Ballauer, Alb C.,** Airplane Div., Curtiss-Wright Corp.
T **Ballou, L. Farwell, Jr.,** Consolidated Aircraft Corp.
T **Balloussier, Major Oswaldo O.,** Ministerio de Aeronautica, Brazil.
T **Bank, Herman,** Vega Aircraft Corp.
M **Banks, Charles R.,** American Airlines, Inc.
M **Baptist, William E.,** National Motor Springs Pty. Ltd., Australia.
T **Barber, E. R.,** Pan American Airways System.
T **Barbero, Achille T.,** Grumman Aircraft Eng. Corp.
M **Bardsley, John W.,** Central Technical School of Toronto, Canada.
M **Barish, Thomas,** Marlin Rockwell Corp.
M **Barker, Fred W.,** Patent Attorney.
T **Barksdale, L. S.,** Lockheed Aircraft Corp.
AF **Barling, Walter H.,** Consolidated Aircraft Corp.
AF **Barlow, Prof. Howard W.,** A. & M. College of Texas.
F **Barlow, Thomas M.,** Fairey Aviation Co., Ltd., England.
T **Barlow, William H.,** Langley Mem. Aero. Lab., N.A.C.A.
F **Barnaby, Comdr. Ralph S.,** U.S. Navy.
AF **Barnard, Dr. D. P.,** Standard Oil Co. (Ind.).
T **Barnes, John C.,** Vultee Aircraft, Inc.
T **Barnes, Louis E.,** General Motors Corp.
T **Barnes, Robert H.,** Ames Aero. Lab., N.A.C.A.
T **Barnes, Thomas H.,** Boeing Aircraft Co.
M **Barratt, Roswell F.,** Meteorologist.
M **Barrie, Major Allan A.,** U.S. Army Air Forces.
T **Barter, Leroy D.,** Univ. of Washington.
T **Barton, Allen B.,** U.S. Navy.
M **Barton, Prof. Millard V.,** Univ. of Texas.
T **Barzda, Justin J., Jr.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Barzelay, Martin E.,** Pratt, Read & Co.
T **Baseler, Richard T.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Baskin, Jack,** Brewster Aeronautical Corp.
AF **Bass, Ernest L.,** England.
T **Bassett, Curtiss D.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
F **Bassett, Preston R.,** Sperry Gyroscope Co., Inc.
T **Batchelder, E. Barron.**
T **Batchelor, Lt. Burton H.,** U.S. Navy.
AF **Bateman, Dr. Harry,** Calif. Inst. of Tech.
T **Bates, Francis, Jr.,** Vega Aircraft Corp.
AF **Bates, Mortimer F.,** Sperry Gyroscope Co., Inc.
T **Bates, William E., Jr.,** Propeller Div., Curtiss-Wright Corp.
AF **Batesole, D. E.,** Norma-Hoffmann Bearings Corp.
T **Battaglia, Joseph C.,** Boeing Aircraft Co.; Frankfort Sailplane Co.
AF **Bauch, F. K.,** Goodyear Aircraft Corp.
M **Bauer, George C.,** Curtiss-Wright Tech. Inst.
M **Bauer, Paul S.,** North Shore News Co.
I **Baughman, Harold E.,** Aero Publishers, Inc.
AF **Baxley, C. H.,** International Aviation Associates.
M **Bayless, Ralph L.,** Consolidated Aircraft Corp.
T **Beach, William I.,** North American Aviation, Inc.
AF **Beadle, F. P. Hyde,** de Havilland Aircraft of Canada Ltd., Canada.
AF **Beall, A. L.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
M **Beall, Wellwood E.,** Boeing Aircraft Co.
I **Bean, John B.,** Aviation Patent Attorney.
T **Beardsley, Lt. George F.,** U.S. Navy.
AF **Beardsley, Guy E., Jr.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
M **Beauvais, Robert F.,** Soc. des Moteurs Gnome et Rhone.
T **Beaver, Russell H., Jr.,** Boeing Aircraft Co.
T **Bebie, Hans,** The Glenn L. Martin Co.
M **Bechberger, P. F.,** Pioneer Instrument Div., Bendix Aviation Corp.
T **Beck, Carl A.**
AF **Beck, Peter A.,** Lockheed Aircraft Corp.
T **Becker, Edward S., Jr.,** Bellanca Aircraft Corp.
T **Becker, John V.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Becker, Louis F., Jr.,** North American Aviation, Inc.
T **Becker, Richard K.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Beckley, Lawrence E.,** Mass. Inst. of Tech.
M **Beckwith, W. Boynton,** Boeing School of Aeronautics.
T **Bednarek, Michael V.,** Douglas Aircraft Co., Inc.
T **Bedrosian, Edward,** Consolidated Aircraft Corp.
M **Beebe, Murray C., Jr.,** Hamilton Standard Propellers Div., United Aircraft Corp.
M **Beech, Walter H.,** Culver Aircraft Corp.; Beech Aircraft Corp.
T **Beemer, Harold R.,** Vultee Aircraft, Inc.
M **Beers, Henry N.,** U.S. Aviation Underwriters, Inc.
T **Beeson, Robert G.,** U.S. Army Air Forces.
M **Beeuwkes, Dr. Reinier, Jr.,** War Dept.
T **Beil, W. John,** Airplane Div., Curtiss-Wright Corp.
T **Beineman, Charles H.,** War Dept.
F **Beisel, Rex B.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.

M **Belinn, Clarence M.,** Kansas City Southern Airlines; Matson Navigation Co.; Hawaiian Airlines Ltd., Hawaii.
T **Belitz, Hans G.,** War Dept.
T **Bell, C. F., Jr.,** The Glenn L. Martin Co.
T **Bell, E. Barton,** Langley Mem. Aero. Lab., N.A.C.A.
T **Bell, Frank G.,** Pan American Airways System.
M **Bell, John,** Aeronautical Lecturer, England.
T **Bell, John F.,** U.S. Army Air Forces.
I **Bell, Lawrence D.,** Bell Aircraft Corp.
AF **Bell, Stanley A.,** Hughes Aircraft Co.
T **Bell, W. T.,** Douglas Aircraft Co., Inc.
F **Bellanca, Giuseppe M.,** Bellanca Aircraft Corp.
T **Beller, William S.,** Hughes Aircraft Co.
T **Belsley, Steven E.,** Ames Aero. Lab., N.A.C.A.
T **Belvin, Ens. Dan L.,** U.S. Navy.
T **Belzer, Maurice,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Bemer, Robert W.,** Douglas Aircraft Co., Inc.
T **Bender, Welcome W., Jr.,** The Glenn L. Martin Co.
I **Bendix, Vincent.**
M **Benedict, Mark C.,** The Glenn L. Martin Co.
T **Benneck, Conbert H.,** Kollsman Instrument Div., Square D Co.
T **Benner, Claude J.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Bennett, Dwight H.,** Consolidated Aircraft Corp.
T **Bennett, Harold.**
M **Bennett, Dr. James A. J.,** Cierva Autogiro Co., Ltd., England.
T **Bennett, John T.,** Northrop Aircraft, Inc.
T **Benny, Richard C.,** Boeing Aircraft Co.
M **Bentley, George P.,** Waltham Watch Co.
T **Bentley, Dr. Edward P.,** Mass. Inst. of Tech.
I **Bercovitz, Bernhard,** Canadian Aircraft Instrument & Accessories, Ltd., Canada.
M **Berdelman, Harry A.,** Lockheed Aircraft Corp.
T **Berg, Carl, Jr.,** Spartan Aircraft Co.
T **Bergdolt, Lt. V. E.,** U.S. Army.
M **Bergen, William B.,** The Glenn L. Martin Co.
M **Berger, Emric W.,** Consolidated Aircraft Corp.
T **Bergey, Milton C.,** Grumman Aircraft Eng. Corp.
T **Berggren, Lloyd E.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
AF **Bergh, Roland C.,** Republic Aviation Corp.
T **Bergholt, Fred B.,** Bergholt Laboratories.
M **Bergman, T. F.,** Wright Aero Ltd.
T **Berinati, Vincent J.,** Bristol Aircraft Div., Universal Moulded Products Corp.
T **Berko, Lawrence,** Airplane Div., Curtiss-Wright Corp.
M **Berkow, Murray,** Republic Aviation Corp.
T **Berler, Irving,** Republic Aviation Corp.
F **Berlin, Don R.,** General Motors Corp.
F **Berliner, Lt. Col. Henry A.,** U.S. Army Air Forces.
T **Berne, Lt. Richard,** U.S. Army.
T **Berner, Robert L.,** The Glenn L. Martin Co.
T **Bernstein, Allen I.,** Airplane Div., Curtiss-Wright Corp.
T **Bernstein, Seymour F.,** Eastern Aircraft Div., General Motors Corp.
I **Berry, Ethan A.,** Chicago Pneumatic Tool Co.
T **Berry, Lt., J. R., Jr.,** U.S. Army Air Forces.
I **Bertrandias, Lt. Col. V. E.,** U.S. Army Air Forces.
AF **Bevan, Lt. Col. William A.,** U.S. Army Air Forces.
T **Beven, Kenneth A.,** Douglas Aircraft Co.
T **Bevins, James E.,** Pioneer Instrument Div., Bendix Aviation Corp.
T **Bezdecheck, William D., Jr.,** Douglas Aircraft Co., Inc.
T **Bichon, Gene W.,** Navy Dept.
T **Bickford, Robert P.,** U.S. Army Air Forces.
M **Bicknell, Joseph,** Mass. Inst. of Tech.
M **Biddlecombe, C. H.,** British Air Commission.
T **Bielat, Ralph P.,** Langley Mem. Aero. Lab., N.A.C.A.
I **Bigelow, Dr. Maurice H.,** Plaskon Co.
T **Bikle, Paul F., Jr.,** Taylorcraft Aviation Corp.
T **Billings, Henry C.,** War Dept.
T **Billups, James O.,** Lockheed Aircraft Corp.
AF **Biot, Prof. Maurice A.,** Calif. Inst. of Tech.
T **Bird, William H. S.,** Canadian Car & Foundry Co., Ltd., Canada.
T **Birely, W. Paul,** Douglas Aircraft Co., Inc.
T **Birnbaum, Daniel S.,** Vega Aircraft Corp.
T **Bisplinghoff, Raymond L.,** Univ. of Cincinnati.
T **Bissinger, Barney,** Cornell Univ.
M **Bittner, Raymond A.,** War Dept.
M **Bixler, Donald,** Sinclair Refining Co.
T **Bjerke, Allan E.,** Airplane Div., Curtiss-Wright Corp.
F **Bjerknes, Prof. V. F. K.,** Univ. of California.
M **Black, Archibald,** Snead & Co.
T **Black, Nelms,** Goodyear Aircraft Corp.
M **Black, Richard L.,** Northrop Aircraft, Inc.
M **Bladen, David H.,** Edo Aircraft Corp.
AF **Blair, Col. Wm. R.,** Automatic Electric Co.
M **Blaisdell, Prof. Allen H.,** Carnegie Inst. of Tech.
T **Blake, Charles L.,** Consolidated Aircraft Corp.
T **Blake, Ralph L.,** Boeing Aircraft Co.
T **Blake, Robert W.,** Pan American Airways System.
T **Blake, Tenney E.,** Lockheed Aircraft Corp.
T **Blakely, Carl F.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Blakely, Matthew L.,** Boeing Aircraft Co.
T **Blatz, William J.,** McDonnell Aircraft Corp.
AF **Blaylock, Raymond C.,** Airplane Div., Curtiss-Wright Corp.
M **Bleakney, Dr. William M.,** Lockheed Aircraft Corp.
T **Blenkush, Philip G.,** Aeronca Aircraft Corp.
T **Bloom, Aaron Q.,** War Dept.
AF **Blount, Earl E.,** Airplane Div., Curtiss-Wright Corp.
AF **Bockius, Lt. Comdr. Robert W.,** U.S. Navy.
T **Bockmann, Lt. Wilbur H.,** U.S. Army Air Forces.
M **Bockrath, George E.,** Douglas Aircraft Co., Inc.
T **Boddy, Lee E.,** Ames Aero. Lab., N.A.C.A.
M **Bodemeijer, Dirk,** Netherlands Purchasing Commission.
T **Boden, Robert H.,** Lockheed Aircraft Corp.
M **Boehnlein, Prof. Charles T.,** Univ. of Minnesota.
T **Boetel, V. F.,** Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.
T **Bogdonoff, Seymour M.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Bogen, John S.,** Universal Oil Products Co.
T **Bogert, Lt. Robert C.,** U.S. Army Air Forces.
M **Bogert, Reid,** Douglas Aircraft Co., Inc.
AF **Bolas, Harold,** Crouch-Bolas Aircraft Corp., England.
T **Boll, Fred J.,** Lockheed Aircraft Corp.
AF **Bollay, Dr. William,** Navy Dept.
M **Bolster, Comdr. Calvin M.,** U.S. Navy.
M **Bondor, Frank M.,** C.A.A.
T **Bonell, William H.,** Lockheed Aircraft Corp.
M **Bonham, L. D.,** Lockheed Aircraft Corp.
AF **Bonnalie, Lt. Comdr. Allan F.,** U.S. Navy.
T **Bonney, R. W.,** Consolidated Aircraft Corp.
I **Boon Hartsinck, A. A.**
M **Boothby, Dr. Walter M.,** Mayo Clinic.
T **Boothby, Willard B.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Borofka, Francis J.,** The Glenn L. Martin Co.
T **Boseker, F. John, Jr.,** Hughes Aircraft Co.
T **Boss, Richard E. S., Jr.,** Brewster Aeronautical Corp.
T **Bosserman, Charles A.,** Boeing Aircraft Co.

AF **Boughton, Warren V.,** Douglas Aircraft Co., Inc.
F **Boulton, B. C.,** Lockheed Aircraft Corp.
T **Bounous, Edwin P.,** Grumman Aircraft Eng. Corp.
T **Bouton, G. Innes, Jr.,** Airplane Div., Curtiss-Wright Corp.
T **Bowe, David D.,** Aeroproducts Div., General Motors Corp.
T **Bowen, Lt. John D.,** U.S. Army Air Forces.
M **Bowen, William H.,** Calif. Inst. of Tech.
M **Bower, Capt. Donald L.,** U.S. Army Air Forces.
T **Bowes, Gerald M.,** Lockheed Aircraft Corp.
M **Bowman, Casper J., Jr.,** Republic Aviation Corp.
T **Bowman, John C.,** Univ. of Texas.
I **Bowman, Leslie H.,** Aircraft Sales Co.
M **Bowman, Richard G.,** Republic Aviation Corp.
T **Bowser, James W.,** Vega Aircraft Corp.
T **Box, William A.,** Lockheed Aircraft Corp.
T **Boykin, J. Arthur, Jr.,** War Dept.
T **Boyle, Thomas H.,** Navy Dept.
M **Braddon, Frederick D.,** Sperry Gyroscope Co., Inc.
T **Bradley, Lt. F. X.,** U.S. Army Air Forces.
AF **Bradley, Richard F.,** Standard Oil Co. of Calif.
M **Bradley, Samuel S.,** Manufacturers Aircraft Association.
F **Brady, George W.,** Propeller Div., Curtiss-Wright Corp.
M **Bragg, Caleb S.,** C. M. Keys Aircraft Service.
T **Braithwaite, J. W.,** Vega Aircraft Corp.
T **Branning, Ralph I., Jr.,** Douglas Aircraft Co., Inc.
T **Branson, Orland D.,** Lockheed Aircraft Corp.
T **Bratsch, Chester H.,** Vultee Aircraft, Inc.
T **Bratt, Robert W.,** Univ. of Minnesota.
T **Brattvet, Robert W.,** Pan American Airways System.
T **Brazier, J. Grant,** Douglas Aircraft Co., Inc.
I **Breckinridge, Henry,** Dowty Equipment Corp.
I **Bree, Albert,** Brewster Aeronautical Corp.
I **Breech, Ernest R.,** Bendix Aviation Corp.
M **Breese, Vance,** Consulting Engineer; Test Pilot.
T **Breitenbach, Max J.,** Consolidated Aircraft Corp.
T **Brenkert, Ingvald K.,** Ford Motor Co.
HM **Brett, Lt. Gen. George H.,** U.S. Army Air Forces.
T **Breuhaus, W. O.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Brewer, Walter B., Jr.,** Airplane Div., Curtiss-Wright Corp.
T **Brewster, James H.,** United Aircraft Corp.
T **Brice, Philip E. R.,** Republic Aviation Corp.
M **Brie, Wing Comdr. R.A.C.,** R.A.F.; British Air Commission.
T **Bricker, E. I.,** Georgia School of Tech.
T **Brierton, James L.,** Airplane Div., Curtiss-Wright Corp.
T **Briggs, Emerson C.,** Bell Aircraft Corp.
F **Briggs, Dr. Lyman J.,** National Bureau of Standards.
AF **Brimm, Daniel J.,** Navy Dept.
I **Brinckerhoff, William W.,** Brown, Crosby & Co.
T **Brittan, Raymond O.,** Northrop Aircraft, Inc.
T **Britton, E. Robert,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Broadhead, Paul S.,** Airplane Div., Curtiss-Wright Corp.
T **Brock, Horace,** Pan American Airways System.
T **Brodie, Donald F.,** Airplane Div., Curtiss-Wright Corp.
T **Brogger, Charles C.,** Camfield Mfg. Co.
F **Brombacher, Dr. William G.,** National Bureau of Standards.
M **Bromberg, B. G.,** Vultee Aircraft, Inc.
T **Brooke, Hubert E.,** Consolidated Aircraft Corp.
AF **Brooks, A. Raymond,** Bell Telephone Laboratories, Inc.
AF **Brooks, Prof. Charles F.,** Blue Hill Observatory, Harvard Univ.
T **Brooks, Emerson H.,** Lockheed Aircraft Corp.
T **Brooks, Frederick T.,** Lockheed Aircraft Corp.
T **Brossell, Kenneth S.,** Boeing Aircraft Co.
M **Brow, Comdr. H. J.,** U.S. Navy.
T **Brown, C. Blair, Jr.,** The Glenn L. Martin Co.
T **Brown, Charles D.,** Communication Products Co.
T **Brown, Lt. Chester H., Jr.,** U.S. Army.
T **Brown, Edmund D.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
AF **Brown, Frank N. M.,** Univ. of Notre Dame.
T **Brown, Harry W.,** Univ. of Texas.
M **Brown, Flight Lt. R.C.C.,** R.C.A.F., Canada.
T **Brown, Capt. Robert,** South African Air Force.
T **Brown, Russell W.,** Douglas Aircraft Co., Inc.
T **Brown, William E.,** Airplane Div., Curtiss-Wright Corp.
AF **Brown, Lt. Col. William G.,** U.S. Army Air Forces.
M **Brownback, Henry L.,** Consulting Engineer.
AF **Browne, Kenneth A.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
M **Brugger, Richard G.,** Sperry Gyroscope Co., Inc.
M **Bruhn, Prof. E. F.,** Purdue Univ.
I **Brukner, Clayton J.,** Waco Aircraft Co.
AF **Bryan, Guy L., Jr.,** The Glenn L. Martin Co.
T **Bryan, Harold E.,** Airplane Div., Curtiss-Wright Corp.
T **Bryant, Routt A., Jr.,** Consolidated Aircraft Corp.
F **Buchanan, John S.,** Air Ministry, England.
AF **Buck, Richard S.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Buckley, Edmond C.,** Langley Mem. Aero. Lab., N.A.C.A.
I **Budds, Henry H.,** Ranger Aircraft Engines Div., Fairchild Engine & Airplane Corp.
T **Buie, John C.,** Mackenzie Air Service, Ltd., Canada.
T **Bull, Charles G.,** R.C.A.F., Canada
F **Bulman, George P.,** Air Ministry, England.
M **Bulman, P. W. S.,** Hawker Aircraft, Ltd., England.
M **Burchett, P. J.,** Pasadena Junior College.
M **Burchfield, William F.,** International Nickel Co., Inc.
T **Burd, Edward,** Emerson Electrical Mfg. Co.
M **Burden, W. A. M.,** Dept. of Commerce.
T **Burgeson, John E.,** Ryan Aeronautical Co.
F **Burgess, Charles P.,** Navy Dept.
T **Burghardt, J. E.,** The Glenn L. Martin Co.
I **Burke, Edward,** Aircraft Accessories Corp.
M **Burke, John F.,** American Export Airlines.
T **Burke, Louis L.,** American Central Mfg. Corp.
T **Burke, Robert E.,** Vultee Aircraft, Inc.
T **Burke, Woodward,** Brewster Aeronautical Corp.
T **Burkland, Charles W.,** Airplane Div., Curtiss-Wright Corp.
M **Burnell, Edwin J.,** Vultee Aircraft, Inc.
AF **Burnelli, Vincent J.,** V. J. Burnelli Airplanes, Inc.
T **Burnham, L. C.,** Bell Aircraft Corp.
T **Burns, Charles E.,** Vega Aircraft Co.
T **Burns, Meryl C.,** Pan American Airways System.
T **Burns, Lt. Robert R.,** U.S. Marine Corps.
T **Burrier, Horace E.,** North American Aviation, Inc.
T **Burroughs, Richard H., Jr.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Burstein, Adolph,** Vultee Aircraft, Inc.
M **Burton, Alexander T.,** North American Aviation, Inc.
AF **Burwell, Dr. Arthur W.,** Alox Corp.
T **Buschmann, Rudi P.,** Lockheed Aircraft Corp.
T **Bush, Robert G.,** Boeing Aircraft Co.
T **Butcher, James A.,** Northwest Airlines, Inc.
T **Butler, Joseph P.,** Boeing Aircraft Co.
T **Butman, Lt. P. M.,** U.S. Army Air Forces.
T **Butt, Charles S., Jr.,** War Dept.
AF **Butterfield, Prof. T. E.,** Lehigh Univ.
T **Butterworth, A. Arnold,** U.S. Navy.

T **Buzzetti, Charles J.,** Lockheed Aircraft Corp.
T **Bye, A. J.,** Fairchild Aircraft, Ltd., Canada.
M **Byers, Dr. Horace R.,** Univ. of Chicago.
T **Bynum, George T., Jr.,** Airplane Div., Curtiss-Wright Corp.

T **Cahill, Jones F.,** Langley Mem Aero. Lab., N.A.C.A.
F **Caldwell, Frank W.,** United Aircraft Corp.
T **Calvert, Harry B.,** Boeing Aircraft Co.
T **Cameron, John E.,** American Central Mfg. Corp.
AF **Caminez, Harold,** Lycoming Div., Aviation Mfg. Corp.
I **Campbell, Douglas,** Pan American-Grace Airways, Inc., Peru.
T **Campbell, Forrest, Jr.,** Waco Aircraft Co.
AF **Campbell, Harris S.,** Consulting Engineer.
AF **Campbell, Kenneth,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Campbell, R. Gordon,** B. F. Goodrich Co.
T **Campbell, Stuart W.,** Lockheed Aircraft Corp.
M **Campbell, William F.,** National Research Council, Canada.
T **Camping, Robert L.,** Aeroproducts Div., General Motors Corp.
M **Cannon, Wayne D.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Cantor, Myron A.,** Airplane Div., Curtiss-Wright Corp.
T **Cantwell, Raymond A.,** Tri-State College.
F **Capon, Robert S.,** Air Ministry, England.
T **Caprioglio, Elio,** Grumman Aircraft Eng. Corp.
T **Carah, Alfred J.,** Douglas Aircraft Co., Inc.
AF **Carbonara, Victor E.,** Kollsman Instrument Div., Square D Co.
T **Carchia, A. Raymond,** Navy Dept.
T **Carder, Alden B.,** Douglas Aircraft Co., Inc.
T **Carey, Paul S.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Carlson, C. Lawrence,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Carlson, Ens. Harold E.,** U.S. Navy.
T **Carlson, Russell M.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Carman, LeMoyne R.,** Boeing Aircraft Co.
T **Carney, P. G.,** Goodyear Aircraft Corp.
T **Carpenter, Adelbert,** Navy Dept.
T **Carpenter, Dale,** Pan American Airways System.
T **Carpenter, Donald T.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
AF **Carpenter F., Major Ivan,** Parque Central de Aviacao, Brazil.
I **Carr, Gardner W.,** McDonnell Aircraft Corp.
T **Carran, John A.,** Republic Aviation Corp.
T **Carrier, Ens. Charles R., Jr.,** U.S. Navy.
T **Carroll, Arthur F.,** Vega Aircraft Corp.
M **Carry, Wm. J.,** The B. G. Corp.
T **Carson, Howard T.,** Aeroproducts Div., General Motors Corp.
AF **Carter, Col. Clifton C.,** Curtiss-Wright Tech. Inst.
T **Carter, George D.,** Vega Aircraft Corp.
AF **Carter, Leslie F.,** Sperry Gyroscope Co., Inc.
T **Caruba, Michael A.,** Brewster Aeronautical Corp.
T **Carver, George P.,** Lockheed Aircraft Corp.
T **Cary, Charles O.,** American Airlines, Inc.
T **Cascadden, Lewis E.,** Airplane Div., Curtiss-Wright Corp.
T **Cassese, Salvatore,** War Dept.
T **Castiglione, Frank P.,** Dept. of Commerce.
T **Castle, Frederick W.,** U.S. Army Air Forces.
T **Castles, Walter, Jr.,** Aviation Eng. Corp.
T **Caswell, Vincent E.,** Vultee Aircraft, Inc.
M **Cathaway, Russ G.,** Fletcher Aviation Corp.
M **Cattaneo, Dr. Alfred G.,** Shell Development Co.
M **Cautley, John R.,** Bendix Products Div., Bendix Aviation Corp.
T **Ceccarelli, John F.,** The Glenn L. Martin Co.
T **Cerna, Robert F.,** Ryan School of Aeronautics.
T **Cerny, Richard J.,** Goodyear Aircraft Corp.
AF **Cerny, Walter J.,** Northrop Aircraft, Inc.
AF **Chaffee, Walter C., Jr.,** Airplane Div., Curtiss-Wright Corp.
T **Chamberlain, Orville, V.,** War Dept.
M **Chamberlin, Fred S.** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Chambers, James C.**
M **Chambers, Reed M.,** U.S. Aviation Underwriters, Inc.; Defense Supplies Corp.
T **Champion, Albert P.,** Lockheed Aircraft Corp.
T **Champlain, Capt. Daniel D.,** U.S. Army Air Forces.
T **Champney, William B.,** Guggenheim Airship Inst.
AF **Chandler, M. E.,** Chandler-Evans Corp.
T **Chandler, Roger L.,** Boeing Aircraft Co.
T **Chang, Fred,** Langley Aviation Corp.
M **Chapel, Charles E.,** Twentynine Palms Air Acad.
M **Chapline, George F.,** Brewster Aeronautical Corp.
M **Chapman, Everett,** Lukenweld, Inc.
T **Chapman, Frank B.,** A. & M. College of Texas.
T **Chapman, Randall N.,** Laister-Kaufmann Aircraft Corp.
AF **Charavay, Frederick,** Hartzell's Industries, Inc.
T **Chardon, Felix,** Brewster Aeronautical Corp.
T **Charles, Lt. Bernard N.,** U.S. Army Air Forces.
T **Charters, Dr. Alexander C., Jr.,** War Dept.
T **Chase, E. Paul,** Consolidated Aircraft Corp.
F **Chatfield, Charles H.,** United Aircraft Corp.
T **Cheatham, Thomas A., Jr.,** War Dept.
T **Chen, Ou-Wen Winston,** Republic Aviation Corp.
M **Cheney, Harold K.,** Vultee Aircraft, Inc.
I **Cheney, Joseph J.,** Spriesch Tool & Mfg. Co., Inc.
T **Cherniak, George S.,** Mass. Inst. of Tech.
T **Cherwony, Alexander,** Airplane Div., Curtiss-Wright Corp.
T **Chevedden, Ray T.,** Lockheed Aircraft Corp.
F **Chien, Lt. Col. C. T.,** Chinese Air Force, China.
AF **Child, Edward R.,** Airplane Div., Curtiss-Wright Corp.
AF **Child, Henry L.,** Airplane Div., Curtiss-Wright Corp.
M **Childers, Milford G.,** Lockheed Aircraft Corp.
M **Chillson, Charles W.,** Propeller Div., Curtiss-Wright Corp.
F **Chilton, Allan,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Chilton, Ernest G.,** Univ. of Akron.
T **Chin, Charles,** Airplane Div., Curtiss-Wright Corp.
T **Chin, Harry B.,** Boeing School of Aeronautics.
T **Chitwood, H. Delmar,** Cessna Aircraft Corp.
M **Chmel, Joseph K.,** Progress & Eng. Corp., Canada.
T **Chow, Lewis,** Noorduyn Aviation Ltd., Canada.
T **Chris, Stephen J.,** Douglas Aircraft Co., Inc.
T **Christenson, Charles H.,** Bristol Aircraft Div., Universal Moulded Products Corp.
T **Christie, Sidney A.,** Ryan Aeronautical Co.
T **Christy, Roland,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Churbuck, Lewis M.,** Aeronautical Univ.
M **Ciffrin, Dr. Assaf,** Consulting Engineer.
M **Clapp, Lt. Comdr. Vernon O.,** American Export Airlines.
AF **Clark, Dr. Charles C.,** U.S. Weather Bureau.
T **Clark, Clayton L.,** War Dept.
M **Clark, James M.,** Manufacturers Aircraft Association.
T **Clark, Perry A.,** United Aircraft Service Corp.
T **Clark, Robert C.,** The Glenn L. Martin Co.
T **Clark, Robert J.,** Douglas Aircraft Co., Inc.
F **Clark, V. E.,** Hughes Aircraft Co.
AF **Clark, W. Douglas,** Navy Dept.
I **Clark, William H.,** Alox Corp.
T **Clarkson, Mark H.,** Douglas Aircraft Co., Inc.
T **Clauser, Dr. Francis,** Douglas Aircraft Co., Inc.

T **Clayton, Fred W., Jr.,** Airmantech.
AF **Clayton, Walter C.,** Curtiss-Wright Tech. Inst.
T **Cleary, H. E.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Clements, Lawrence V.,** Vultee Aircraft, Inc.
M **Clements, Norman V.,** United Aircraft Corp.
M **Cleveland, E. W.,** Cleveland Pneumatic Tool Co.
T **Clifford, Lawrence B.,** R.C.A.F., Canada.
AF **Clousing, Lawrence A.,** Ames Aero. Lab., N.A.C.A.
M **Coan, Prof. John M., Jr.,** Iowa State College.
M **Coburn, James M., Jr.,** War Dept.
T **Coe, John M.,** Grumman Aircraft Eng. Corp.
M **Coffyn, Frank T.,** Wings Club.
T **Cohan, Sid,** Douglas Aircraft Co., Inc.
T **Cohen, Eli L.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Cohn, Benedict,** Boeing Aircraft Co.
T **Cokliss, Oscar E.,** Consolidated Aircraft Corp.
T **Cole, Lt. Chas. W.,** Boeing Aircraft Co.
T **Cole, Lt. Donald M., Jr.,** Vega Aircraft Corp.
T **Cole, Hermon H., Jr.,** McDonnell Aircraft Corp.
T **Cole, R. W.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
M **Cole, Robert A.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Cole, Russell H.,** Vard Mechanical Lab.
T **Coleman, Gerald W.,** Vultee Aircraft, Inc.
M **Coleman, Robert P.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Colen, Donald J.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Collazo, Lt. Anibal F.,** Argentine Navy, Argentina.
AF **Collbohm, Franklin R.,** Douglas Aircraft Co., Inc.
T **Collins, Lt. Carvel E.,** U.S. Navy.
T **Collins, Francis M.,** The Glenn L. Martin Co.
T **Collins, F. Thomas,** Douglas Aircraft Co., Inc.
M **Collins, Lt. M. E.,** U.S. Navy.
M **Colman, Philip A.,** Lockheed Aircraft Corp.
F **Colvin, Charles H.,** New York Univ.
AF **Colwell, Archie T.,** Thompson. Products, Inc.
T **Combs, Henry G.,** Curtiss-Wright Tech. Inst.
M **Comp, Prof. L. A.,** Univ. of Oklahoma.
T **Compter, George H.,** Brewster Aeronautical Corp.
F **Compton, Dr. Karl T.,** Mass. Inst. of Tech.
M **Conace, Frank,** Sperry Gyroscope Co., Inc.
I **Condon, Cyril Hyde,** Attorney.
T **Cone, Douglas B.,** Lockheed Aircraft Corp.
M **Cone, J. Carroll,** Pan American Airways System.
T **Congdon, Richard I.,** Pan American Airways System.
AF **Conlon, Lt. Emerson W.,** U.S. Navy.
T **Connel, William A.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Conner, Daniel M.,** Douglas Aircraft Co., Inc.
T **Connor, G. A.,** Airplane Div., Curtiss-Wright Corp.
T **Conviser, Albert A.,** Uneeda-National, Inc.
T **Conway, H. M., Jr.,** N.A.C.A.
T **Conway, Robert N.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Cook, Major Frank R.,** U.S. Army Air Forces.
T **Cook, Leslie W.,** Hastings Mfg. Co.
T **Cook, Stanley A.,** The Glenn L. Martin Co.
M **Cook, William H.,** Boeing Aircraft Co.
T **Cooke, Leonard,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
AF **Coombes, Lawrence P.,** Committee of Scientific & Industrial Research, Australia.
I **Cord, Errett L.**
M **Cornelius, George W.,** Cornelius-Hoepli Corp.
T **Cornelius, Walter,** General Motors Research Lab.
M **Cornell, Lt. B. M.,** U.S. Army Air Forces.
T **Cornell, Wellington C.,** The Glenn L. Martin Co.
T **Cornog, Robert A.,** Princeton Univ.
M **Corwin, Prof. Elbert F.,** Rensselaer Polytech. Inst.
T **Cosbey, Edward, Jr.,** Bell Aircraft Corp.
T **Cosner, Norman D.,** Meyers Aircraft Co.
T **Cote, Lt. Oliver H., Jr.,** U.S. Navy.
M **Cotton, Thomas J., Jr.,** Navy Dept.
T **Coulston, Lt. Richard M.,** U.S. Army Air Forces.
M **Courtney, Francis T.,** Consolidated Aircraft Corp.
M **Coutinho, John De S.,** Grumman Aircraft Eng. Corp.
T **Coven, Robert H.,** Parks Air College.
T **Coverston, Carl,** Ryan Aeronautical Co.
T **Covington, Donald K., Jr.,** The Glenn L. Martin Co.
T **Cowgill, Lee C.,** The Glenn L. Martin Co.
I **Cox, Duncan B.,** Al-Fin Corp.; Fairchild Engine & Airplane Corp.
AF **Cox, H. Roxbee,** Air Registration Board, England.
T **Crabtree, James A.,** North American Aviation, Inc.
T **Craddock, Lt. James R.,** U.S. Army Air Forces.
T **Crane, Lt. John J.,** U.S. Army Air Forces.
T **Crane, Lt. Leon,** U.S. Army Air Forces.
T **Cravero, Joseph A.,** Republic Aviation Corp.
T **Crawford, Herbert R.,** Grumman Aircraft Eng. Corp.
M **Crawford, Marion B.,** Pump Eng. Service Corp.
T **Crichlow, Walter J.,** Vega Aircraft Corp.
T **Crisi, Lt. Alfred R.,** U.S. Army Air Forces.
T **Crocker, Albert R.,** Eng. & Research Corp.
T **Crockett, Harold B.,** Lockheed Aircraft Corp.
T **Crofut, E. G.,** Calif. Inst. of Tech.
T **Crook, James M.,** Lockheed Aircraft Corp.
T **Crosby, Frank M.,** Bell Aircraft Corp.
T **Croshere, A. B., Jr.,** Douglas Aircraft Co., Inc.
T **Crossland, Frank J.,** Boeing Aircraft Co.
T **Crotsley, H. H.,** Airplane Div., Curtiss-Wright Corp.
AF **Crouch, R. J. Goodman,** Crouch-Bolas Aircraft Corp., England.
T **Crow, L. D.,** Parks Air College.
AF **Crowe, J. H.,** England.
F **Crowley, John W., Jr.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Crowther, Gwynn, Jr.,** Ryan Aeronautical Co.
T **Crozat, Donald F.,** Propeller Div., Curtiss-Wright Corp.
M **Cudhea, George G.,** Fleetwings, Inc.
T **Culver, Charles A.,** North American Aviation, Inc.
T **Curr, Maurice D.,** Consolidated Aircraft Corp.
T **Curry, Robert C.,** Casey Jones School of Aeronautics.
T **Cushman, Maurice E.,** Propeller Div., Curtiss-Wright Corp.
T **Czarnecki, Kaz. R.,** Langley Mem. Aero. Lab., N.A.C.A.

T **Daggett, Myron L., Jr.,** Airplane Div., Curtiss-Wright Corp.
T **Dagley, Chester A., Jr.,** Boeing Aircraft Co.
AF **Daland, Elliot.**
T **Dallenbach, Frederick,** Northrop Aircraft, Inc.
T **Dalva, Edward,** Grumman Aircraft Eng. Corp.
F **Damon, Ralph S.,** Republic Aviation Corp.
T **Daniels, Walter, Jr.,** North American Aviation, Inc.
T **Dannenberg, Robert E.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Dansfield, Robert R.,** Boeing Aircraft Co.
M **Darby, Robert A.,** Airplane Div., Curtiss-Wright Corp.
M **Darragh, James B., Jr.,** Lockheed Aircraft Corp.
M **Da Silva, Capt. João M.,** Brazilian Aeronautical Commission.
T **Daughaday, Hamilton,** Airplane Div., Curtiss-Wright Corp.
M **Davidsen, J. S. W.,** Ames Aero Lab., N.A.C.A.
M **Davidson, Ens. Eugene S.,** U.S. Naval Reserve.
M **Davidson, G. Graham,** Airplane Div., Curtiss-Wright Corp.
AF **Davidson, Prof. Kenneth S.,** Stevens Inst. of Tech.
AF **Davidson, Ward F.,** Consolidated Edison Co. of N.Y.
M **Davies, C. E.,** American Society of Mechanical Engineers.

M **Davies, C. W.,** Douglas Aircraft Co., Inc.
T **Davies, Walter M.,** Airplane Div., Curtiss-Wright Corp.
T **Davis, Lt. Craig C.,** U.S. Army Air Forces.
T **Davis, Ens. Frank F.,** U.S. Navy.
T **Davis, H. C.,** Casey Jones School of Aeronautics.
T **Davis, James E.,** Navy Dept.
T **Davis, M. J.,** Lockheed Aircraft Corp.
T **Davis, Samuel,** Noorduyn Aviation, Ltd., Canada.
T **Davis, Wallace F.,** Ames Aero. Lab., N.A.C.A.
T **Davis, William L., Jr.,** Airplane Div., Curtiss-Wright Corp.
M **Davison, Col. F. Trubee,** U.S. Army Air Forces.
AF **Day, Major Charles H.,** U.S. Army Air Forces.
T **Dean, Floyd M.**
T **de Aquino, Rinaldo R.,** Panair do Brasil S.A., Brazil.
M **Dearborn, C. H.,** Langley Mem. Aero. Lab., N.A.C.A.
AF **DeBell, George W.,** The Thomas Mason Co.
T **DeCenzo, Herbert A.,** American Aviation Corp.
M **de Chappedelaine, Jean,** Netherlands Purchasing Commission.
T **Decker, Lt. W. H.,** U.S. Army Air Forces.
I **Deeds, Charles W.,** Chandler-Evans Corp.
I **Deeds, Edward A.,** National Cash Register Co.
AF **de Florez, Comdr. Luis,** U.S. Navy.
T **de Florez, Peter,** Link Aviation Devices.
F **de Forest, Prof. A. V.,** Mass. Inst. of Tech.; Magnaflux Corp.
F **DeFrance, Smith J.,** Ames Aero. Lab., N.A.C.A.
AF **de Ganahl, Carl,** Fleetwings, Inc.
T **de Graffenried, Albert L.,** Sperry Gyroscope Co., Inc.
T **De Grey, Richard P.,** Lockheed Aircraft Corp.
T **De Hart, J. R.,** Eastern Air Lines, Inc.
F **de Havilland, Capt. G.,** de Havilland Aircraft Co., Ltd., England.
AF **de Kuzmik, Paul,** Pan American Airways System.
T **DeLand, Robert E.,** Airplane Div., Curtiss-Wright Corp.
T **Della-Vedowa, Richard P.,** Lockheed Aircraft Corp.
M **Del Mar, Bruce E.,** Douglas Aircraft Co., Inc.
T **Demas, E. J.,** Transcontinental & Western Air, Inc.
T **Demer, L. J.,** Univ. of Notre Dame.
M **Demler, Major M. C.,** U.S. Army Air Forces.
F **Den Hartog, Lt. Comdr. J. P.,** U.S. Navy.
T **Dennis, Lester T.,** Propeller Div., Curtiss-Wright Corp.
M **den Tex, N. J.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Dentraygues, Jean,** Vega Aircraft Corp.
T **Denzin, Edward C.,** Northrop Aircraft, Inc.
AF **Depew, Richard H., Jr.,** Taylorcraft Aviation Corp.
T **Deregibus, Cleo,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Dernbach, Lt. Anthony F.,** U.S. Army Air Forces.
M **Der Yuen, Frank,** Harlow Aircraft Co.
M **Desmond, Gerald L.,** Navy Dept.
I **de Souza, José Garcia,** Companhia Nacional Navegacão Aerea, Brazil.
M **Devlin, Frank W.,** Consolidated Aircraft Corp.
T **DeWeese, Herbert F.,** Wichita Div., Boeing Aircraft Co.
T **DeWitt, Robert M.,** Hamilton, Standard Propeller Div., United Aircraft Corp.
M **Dexter, Robert R.,** Institute of the Aeronautical Sciences.
M **Deyarmond, Major Albert B.,** U.S. Army Air Forces.
AF **Dichman, Major E. W.,** U.S. Army Air Forces.
T **Dickens, I. Charles,** Ryan Aeronautical Co.
AF **Dickerman, Fred N.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Dickey, Robert R.,** Boeing Aircraft Co.
T **Dickie, John A.,** Lockheed Aircraft Corp.
M **Dickinson, H. B.,** Lockheed Aircraft Corp.
M **Dickinson, Warren T.,** Douglas Aircraft Co., Inc.
T **Dickow, Arthur F.,** North American Aviation, Inc.
F **Diehl, Capt. Walter S.,** U.S. Navy.
T **Dietz, Robert P.**
T **Dietz, William C.,** Consolidated Aircraft Corp.
T **Dilatush, Howard B., Jr.,** Navy Dept.
M **Dill, Lt. Col. David B.,** U.S. Army Air Forces.
T **Dill, Douglas G.,** Douglas Aircraft Co., Inc.
T **Dillon, Frederick P.,** Lockheed Aircraft Corp.
T **Dilworth, Lt. John A.,** U.S. Army Air Forces.
T **Dimond, Julius L.,** Aircraft Research Corp.
T **Dingeldein, Richard C.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Dinsmore, J. F.,** Vultee Aircraft, Inc.
T **Di Salvo, Francis J.,** Noorduyn Aviation Ltd., Canada.
T **Ditson, J. D.,** Ingersoll-Rand Co.
T **Diver, John R.,** Aeroproducts Div., General Motors Corp.
T **do Amaral, Clay Presgrave,** Instituto de Pesquisas Tecnologicas, Brazil.
M **Doane, F. B.,** Magnaflux Corp.
T **Dobbins, David T.,** North American Aviation, Inc.
T **Dobkowski, John C.,** Meyer & Heller Eng. Co.
T **Dodd, Lavon C.,** Lockheed Aircraft Corp.
T **Dodge, Charles H.,** Lockheed Aircraft Corp.
T **Dods, J. B., Jr.,** Ames Aero. Lab., N.A.C.A.
M **Dods, J. P.,** Summerill Tubing Co.
T **Doe, Steward W.,** Pan American Airways System.
I **Doe, Thomas B.,** The Sperry Corp.; Sperry Gyroscope Co., Inc.
T **Doering, Frederick J., Jr.,** Ames Aero. Lab., N.A.C.A.
AF **Dolan, C. H.,** Rearwin Aircraft & Engines, Inc.
AF **Doman, Carl T.,** Aircooled Motors Corp.
T **Dommasch, Daniel O.,** C.A.A.
T **Dommers, Walter A.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Don, Daniel,** Murrow Aircraft Corp.
T **Donahue, Joseph P.,** The Glenn L. Martin Co.
T **Donald, H. W.,** Canada.
AF **Donnell, L. H.,** Illinois Inst. of Tech.
T **Donnell, Lt. Ralph H.,** U.S. Army Air Forces.
M **Donnelly, J. P.,** Noorduyn Aviation Ltd., Canada.
M **Donovan, Allen F.,** Curtiss-Wright Corp.
T **Donovan, Charles B.,** Douglas Aircraft Co., Inc.
AF **Donovan, R. C.,** Douglas Aircraft Co., Inc.
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F **Doolittle, Brig. Gen. J. H.,** U.S. Army Air Forces.
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T **Dorris, Lt. George C., Jr.,** U.S. Army Air Forces.
T **Dotts, Homer W.,** Airplane Div., Curtiss-Wright Corp.
T **Doty, Ens. L. F.,** U.S. Navy.
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T **Doubrava, Eugene N.,** Thompson Products, Inc.
T **Doudna, Robert F.,** Boeing Aircraft Co.
HF **Douglas, Donald W.,** Douglas Aircraft Co., Inc.
M **Douglas, Leon L.,** Brewster Aeronautical Corp.
T **Douglas, Robert B.,** Canadian Car & Foundry Co., Canada.
T **Dowden, Edmund V.,** Osborn Mfg. Co.
AF **Dowell, C. P.,** Brewster Aeronautical Corp.
AF **Dowty, George H.,** Dowty Equipment Ltd., England.
AF **Draim, Lt. Comdr. N. A.,** U.S Navy.
F **Draper, Prof. C. S.,** Mass. Inst. of Tech.
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M **Draut, Ralph H.,** The Glenn L. Martin-Nebraska Co.
T **Drescher, H. J.,** Aircraft Engine Research Lab., N.A.C.A.

AF **Driggs, Ivan H.,** Navy Dept.
T **Drinkwater, W. Dale,** Univ. of Minnesota.
T **Driscoll, Lt. B. J.,** U.S. Army Ground Forces.
T **Drummer, A. Milton,** Beech Aircraft Corp.
T **Drummond, W. H. Peter.**
HF **Dryden, Hugh L.,** National Bureau of Standards.
T **Dublin, Michael,** Consolidated Aircraft Corp.
M **Du Bois, Dr. Eugene F.,** Cornell Univ.Medical College; National. Research Council.
T **Dubois, R. G.,** War Dept.
AF **DuBois, R. N.,** Packard Motor Car Co.
M **DuBuque, J. H.,** Pennsylvania-Central Airlines.
M **Dudek, E. F.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Dudek, Oldrich,** Republic Aviation Corp.
M **Dudley, Shepard,** Standard Oil Co. of N.J.
T **Duffendack, J. C., Jr.,** Lockheed Aircraft Corp.
M **Dufort, Robert H.,** Bell Aircraft Corp.
T **Dufrene, Lt. Roland E.,** U.S. Army Air Forces.
T **Dugan, James C.,** War Dept.
T **Dunbar, William R.,** Douglas Aircraft Co., Inc.
T **Duncanson, Donald N.,** War Dept.
M **Dunford, Edward F. B.,** Noorduyn Aviation Ltd., Canada.
T **Dunhofer, Otto J. Veiga.**
T **Dunlop, Lt. H. J.,** U.S. Army Ground Forces.
T **Dunn, Dr. Louis G.,** Calif. Inst. of Tech.
T **Dunn, Orville R.,** Douglas Aircraft Co., Inc.
T **Dunn, Thomas M.,** Pan American-Grace Airways, Inc.
I **Dunning, Albert W.,** Plastics Div., Monsanto Chemical Co.
I **du Pont, A. Felix, Jr.,** Elton Investment Co.; Bellanca Aircraft Corp.
I **du Pont, Richard C.,** All American Aviation, Inc.
T **Dupree, Francis C.,** Kollsman Instrument Div., Square D Co.
HF **Durand, Dr. W. F.,** N.A.C.A.; National Research Council.
T **Dutton, Prof. D. W.,** Georgia School of Tech.
T **Dvorak, Harry W.,** Consolidated Aircraft Corp.
T **Dykes, J. Christopher,** R.A.F. Middle East Communications.
M **Dysart, J. J.,** Pan American Airways System.
T **Dysland, Lloyd S.,** Navy Dept.

T **Eade, Frederick P.,** Twentynine Palms Air Acad.
AF **Eade, Lt. Comdr. Walter F.,** Briggs Mfg. Co.
T **Eames, J. Owen,** Acad. of Aeronautics.
AF **Eastman, Prof. Fred S.,** Univ. of Washington.
AF **Eaton, Bruce G., Jr.,** Airplane Div., Curtiss-Wright Corp.
M **Ebel, Isabel C.,** United Air Lines Transport Corp.
F **Ebel, William K.,** The Glenn L. Martin Co.
T **Ebeling, Wilbur L.,** Wayne Univ.
M **Ebenbach, Robert,** Edward G. Budd Mfg. Co.
T **Eberle, Robert B.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Eck, Carl F.**
T **Edelman, Leonard B.,** Harvard Univ.
AF **Edgar, Dr. Graham,** Ethyl Corp.
AF **Edwards, Lt. Comdr. C. P.,** Dept. of Transport, Canada.
T **Edwards, Milton F.,** Acad. of Aeronautics.
T **Efromson, P. C.,** Vega Aircraft Corp.
T **Egerton, Harry Stuart,** Kellett Autogiro Corp.
T **Egly, Arnold H.,** American Airlines, Inc.
F **Egtvedt, C. L.,** Boeing Aircraft Co.
T **Eichhorn, Walter, Jr.,** Elastic Stop Nut Corp.
AF **Eichler, Edward,** Consulting Aero. Eng.
T **Eikenberry, Robert S.,** Univ. of Notre Dame.
T **Eldridge, Robert A.,** Douglas Aircraft Co., Inc.
M **Ellinger, Ralph L.,** Transcontinental & Western Air, Inc.
T **Elliott, R. D.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
M **Ellis, Chester A.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Ellis, F. E., Jr.**
AF **Ellis, J. T.,** Dow Chemical Co.
T **Ellis, Joseph A.,** War Dept.
AF **Ellis, Robert E.,** Standard Oil Development Co.
M **Ellor, James E.,** Packard Motor Car Co.; Rolls-Royce Ltd., England.
M **Ely, Lawrence D.,** War Dept.
T **Ely, Lt. R. L.,** U.S. Army Air Forces.
I **Emil, Allan D.,** Square D Co.
T **Emmons, Lt. Gen. Delos C.,** U.S. Army Air Forces.
T **Emrich, Vernon G.,** Franklin Sailplane Co.
T **Engebretson, Hartwell E.,** Boeing Aircraft Co.
M **Engelhardt, Lloyd F.,** Airplane Div., Curtiss-Wright Corp.
T **English, J. M.,** British Air Commission.
T **Enk, Eugene S.,** Airplane Div., Curtiss-Wright Corp.
M **Eno, Donald W.,** Pan American Airways System.
AF **Enos, L. H.,** Propeller Div., Curtiss-Wright Corp.
T **Ensrud, A. F.,** Lockheed Aircraft Corp.
T **Entrikin, James E.,** General Electric Co.
AF **Enyart, William R.,** Simmonds Aerocessories, Inc.
T **Epps, L. M., Jr.,** Grumman Aircraft Eng. Corp.
T **Epstein, Aaron,** Consolidated Aircraft Corp.
T **Erickson, Norin E.,** Bell Aircraft Corp.
AF **Erlandsen, Oscar, Jr.,** Grumman Aircraft Eng. Corp.
AF **Espenschied, Lloyd,** Bell Telephone Laboratories, Inc.
T **Estabrook, G. H.,** Lockheed Aircraft Corp.
M **Eubank, Prof. John A.,** Brooklyn Law School; St. Lawrence Univ.
T **Eubanks, J. Thomas,** Lockheed Aircraft Corp.
M **Evans, George D.,** Brewster Aeronautical Corp.
AF **Evans, Stanley H.,** Ryan School of Aeronautics.
M **Eveleth, E. Lincoln,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
AF **Everett, Prof. H. A.,** The Pennsylvania State College.
T **Ewald, C. F.,** Vega Aircraft Corp.
T **Ewert, Edward C.,** Consolidated Aircraft Corp.

F **Fage, Arthur,** National Physical Lab., England.
T **Fahlen, Douglas E.**
AF **Faile, E. H.,** Airport Designer.
AF **Fairbanks, Andrew J.,** Rensselaer Polytech. Inst.
AF **Fairbanks, Edmund U.,** United Air Lines Transport Corp.
M **Fairchild, Sherman M.,** Fairchild Engine & Airplane Corp.; Fairchild Aviation Corp.
F **Fairey, Sir Charles Richard,** Fairey Aviation Co., Ltd., England; British Air Commission.
M **Fake, Comdr. Frank C.,** U.S. Navy.
AF **Fales, E. N.,** C.A.A.
M **Fales, Herbert G.,** International Nickel Co., Inc.; North American Aviation, Inc.
M **Falk, Adolf C.,** Kellett Autogiro Corp.
T **Falvey, J. A.,** Westinghouse Electric & Mfg. Co.
T **Fancher, W. J., Jr.,** Lockheed Aircraft Corp.
T **Farnham, Lt. D. W.,** U.S. Navy.
T **Farrah, Jere T.,** American Airlines, Inc.
F **Farren, W. S.,** Royal Aircraft Establishment, England.
T **Farris, Thomas C.,** Lockheed Aircraft Corp.
M **Faulconer, Thomas P.,** Consolidated Aircraft Corp.
I **Favorite, Lewis P.,** Aluminum Co. of America.
T **Fay, Charles L.,** United Aircraft Corp.
T **Fay, Edwin R.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Fay, G. W.,** Douglas Aircraft Co., Inc.
HF **Fedden, Sir Alfred H. R.,** Bristol Aeroplane Co. Ltd., England.
T **Feddersen, E. Warren,** Consolidated Aircraft Corp.
T **Fedorowski, Joseph G.,** Grumman Aircraft Eng. Corp.
T **Feigen, Morris,** Airplane Div., Curtiss-Wright Corp.
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T **Feldman, Howard,** Snead & Co.

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T **Fell, Lt. Charles L.,** U.S. Army Air Forces.
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T **Ferguson, L. Grant,** Republic Aviation Corp.
AF **Fergusson, S. P.,** Blue Hill Observatory, Harvard Univ.
AF **Ferrier, Air Vice-Marshal A.,** R.C.A.F., Canada.
M **Ferris, Dr. Eugene B., Jr.,** Univ. of Cincinnati School of Medicine.
AF **Ffield, Paul,** Shipbuilding Div., Bethlehem Steel Co.
T **Fieldson, George L.,** United Air Lines Transport Corp.
T **Fine, Marvin N.,** The Glenn L. Martin Co.
T **Fink, Allan K.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Finlay, Donald W.,** Boeing Aircraft Co.
M **Fischel, Lt. J. R.,** U.S. Army Air Forces.
T **Fischer, Andrew J.,** The Continental-Diamond Fibre Co.
T **Fischer, Harold,** Vultee Aircraft, Inc.
T **Fischer, Roger W.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Fischer, Walter W. A.,** United Air Lines Transport Corp.
T **Fishbein, Meyer,** Northrop Aircraft, Inc.
T **Fisher, James Lee, Jr.,** Goodyear Aircraft Corp.
T **Fisher, Joseph A.,** North American Aviation, Inc.
M **Fisk, Albert S.,** Sperry Gyroscope Co., Inc.
I **Fitz, J. A.,** Sperry Gyroscope Co., Inc.
AF **Flader, Fredric,** Airplane Div., Curtiss-Wright Corp.
T **Flake, Harry M.,** Airplane Div., Curtiss-Wright Corp.
T **Flax, Alexander,** Airplane Div., Curtiss-Wright Corp.
I **Fleet, R. H.,** Consolidated Aircraft Corp.
T **Fleisig, Ross,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
AF **Fligg, Lt. Claude M.,** U.S. Navy.
T **Flint, Fred H.,** Airplane Div., Curtiss-Wright Corp.
T **Floyd, J. F. Rabardy,** The Glenn L. Martin Co.
T **Flushman, David,** Douglas Aircraft Co., Inc.
T **Flynn, P. T.,** Lockheed Aircraft Corp.
M **Foa, Joseph V.,** American Aero-Marine Industries, Inc.
F **Folland, H. P.,** Folland Aircraft Ltd., England.
AF **Folsom, Dr. R. G.,** Univ. of California.
M **Fontaine, A. P.,** Vultee Aircraft, Inc.
T **Fontenelle, J. A.,** Panair do Brasil S.A., Brazil.
M **Foottit, H. R.,** R.C.A.F., Canada.
T **Ford, James.**
T **Ford, Lloyd D.,** War Dept.
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T **Formhals, Edwin J.,** The Glenn L. Martin Co.
T **Forney, A. Kenneth,** Navy Dept.
T **Forsythe, Walter W.,** U.S. Navy.
T **Forward, D. J.,** Wickwire Spencer Steel Co.
M **Foster, Edward E.,** Airplane Div., Curtiss-Wright Corp.
T **Foster, R. Mayo,** Ames Aero. Lab., N.A.C.A.
M **Foster, T. R.,** Lockheed Aircraft Corp.
M **Foulois, Major Gen. B. D.,** U.S. Army Air Corps (Ret.).
T **Fowler, Franklin H., Jr.,** Propeller Div., Curtiss-Wright Corp.
I **Fowler, Lt. R. E.,** U.S. Coast Guard.
T **Fox, Reuben B.,** Lycoming Div., Aviation Mfg. Corp.
T **Foy, Egan D., Jr.,** Airplane Div., Curtiss-Wright Corp.
M **Fraas, Arthur P.,** New York Univ.
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AF **Franchimont, H. A.,** Pan American Airways System.
T **Francis, Harold E.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
I **Francis, Parker B.,** Puritan Compressed Gas Corp.
M **Frank, Frederick C.,** Bendix Products Div., Bendix Aviation Corp.
T **Frank, Fred S.,** S & M Flying Services.
T **Frankel, D. P.,** Allison Div., General Motors Corp.
T **Frankel, Meyer.**
M **Franklin, J. C.,** Transcontinental & Western Air, Inc.
T **Franklin, Peter G.,** Curtiss-Wright Tech. Inst.
T **Frantz, William,** Brewster Aeronautical Corp.
M **Fraser, Oliver, Jr.,** Carnegie-Illinois Steel Corp.
F **Frazer, R. A.,** National Physical Lab., England.
T **Frazy, George A.,** United Air Lines Transport Corp.
T **Fredrick, J. Louis,** Airplane Div., Curtiss-Wright Corp.
T **Freedman, Gordon L.,** Freedman-Burnham Eng. Corp.
T **Freeman, Byron,** Airplane Div., Curtiss-Wright Corp.
T **Frei, Ralph E.**
T **Frei, Wallace M.,** Howard Aircraft Corp.
T **Freitag, Ens. Robert F.,** Navy Dept.
AF **Freyermuth, G. H.,** Standard Oil Co. of N.J.
T **Freyvogel, Lt. W. R.,** U.S. Army Air Forces.
T **Frick, Jack E.,** Vega Aircraft Corp.
T **Friedman Jack H.,** American Central Mfg. Corp.
T **Friedman, William S.,** *Air Tech* and *Air News* magazines.
I **Friez, Lucien L.,** Julien P. Friez & Sons Div., Bendix Aviation Corp.
M **Frische, Carl A.,** Sperry Gyroscope Co., Inc.
AF **Fritsche, Carl B.,** Reichhold Chemicals, Inc.
M **Fritz, L. G.,** U.S. Army Air Forces.
M **Froelich, Michael H.,** *Aero Digest* Magazine.
AF **Froesch, Charles,** Eastern Air Lines, Inc.
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T **Frommelt, Warren T.,** Acad. of Aeronautics.
T **Fromuth, Karl F.,** War Dept.
M **Frost, Eugene C.,** Lockheed Aircraft Corp.
T **Frost, Richard H.,** Arens Controls, Inc.
T **Frost, Verne C.,** Republic Aviation Corp.
T **Fruauff, George L., Jr.,** Western Electric Co.
AF **Frye, Jack,** Transcontinental & Western Air, Inc.
M **Fuller, Lt. E. W.,** U.S. Navy.
M **Fuller, Frederic Edwin,** Ranger Aircraft Engines Div., Fairchild Engine & Airplane Corp.
T **Fuller, Ned, Jr.,** Stinson Aircraft Div., Vultee Aircraft, Inc.
T **Fuller, Richard G.**
T **Fuller, Stuart J., Jr.,** U.S. Army Air Forces.
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T **Furlong, G. Chester,** Langley Mem. Aero. Lab., N.A.C.A.
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M **Galt, Byron H.,** Boeing Aircraft Co.
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M **Garges, John P. D.,** Bristol Aeronautical Corp.
M **Gariepy, A. J.,** Defense Supplies Corp.
T **Garrahan, Ben M.,** Braniff Airways.
T **Garrettson, J. A.,** Airplane Div., Curtiss-Wright Corp.
M **Garrott, Martin,** Panair do Brasil S.A., Brazil.
M **Gartseff, Valerian N.,** General Motors Corp.
T **Gaskell, Chester W., Jr.,** Douglas Aircraft Co., Inc.
T **Gaskell, Raymond W.,** Northrop Aircraft, Inc.
AF **Gassner, Alfred A.,** Jenter Corp.
HM **Gates, Hon. Artemus L.,** Navy Dept.

T **Gaubis, Leonard L.,** Bristol Aeronautical Corp.
T **Gausselin, Joseph A.,** Boeing Aircraft Co.
M **Gauvain, William E.,** Navy Dept.
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T **Giannini, G. M.,** Vega Aircraft Corp.
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AF **Gibbs, William Francis,** Gibbs & Cox.
T **Gibson, Flight Lt. M. W.,** R.C.A.F., Canada.
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M **Gilchrist, Gibb,** A. & M. College of Texas.
T **Gill, M. A.,** Propeller Div., Curtiss-Wright Corp.
M **Gillespie, Capt. Harold S.,** Pan American Airways System.
AF **Gillies, B. Allison,** Grumman Aircraft Eng. Corp.
AF **Gillmor, R. E.,** Sperry Gyroscope Co. Inc.; Fairchild Engine & Airplane Corp.
M **Gillmore, W. E.,** Briggs Mfg. Co.
T **Gillooly, Lt. Richard P.,** U.S. Army Air Forces.
T **Gilmer, G. Walker, III,** Pan American Airways-Africa, Ltd.
T **Gilmore, Rex D.,** The Glenn L. Martin Co.
T **Gilruth, R. R.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Gilson, Robert D.,** The Glenn L. Martin Co.
T **Gitt, Edward,** Republic Aviation Corp.
T **Giudice, S. Thomas,** Republic Aviation Corp.
M **Glad, N. C.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Glauser, James E.,** Bendix Aviation Corp.
T **Glenn, John E.,** Northrop Aircraft, Inc.
T **Glenn, Ens. Oliver,** U.S. Navy.
T **Glossa, Milton,** Boeing Aircraft Co.
I **Glover, W. Irving.**
T **Glowa, L. Wm.,** War Dept.
I **Glowinski, Albert D.,** Matam Corp.
F **Gluhareff, Michael E.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
AF **Gluhareff, Serge E.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Go, Chong-Hu,** American Airlines, Inc.
T **Godard, Frank E., Jr.,** The Glenn L. Martin Co.
AF **Goddard, R. H.,** Clark Univ.
AF **Godfrey, E. R., Jr.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
M **Godfrey, Walter,** Snead & Co.
T **Goertzel, Gerald,** New York Univ.
T **Goettert, K. F. W.,** Douglas Aircraft Co., Inc.
T **Goldberg, Alexander,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Goldberg, S. J.,** Douglas Aircraft Co., Inc.
T **Golden, James M.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Goldman, George M.,** War Dept.
T **Goldman, Maurice L., Jr.,** Vega Aircraft Corp.
T **Goldsmith, Morris K.,** Vega Aircraft Corp.
I **Goldsmith, Richard,** The B. G. Corp.
M **Goldstein, J. Richard,** Douglas Aircraft Co., Inc.
M **Goodall, Lt. Ray G.,** U.S. Army Air Forces.
M **Goodlett, E. Ross,** Airplane Div., Curtiss-Wright Corp.
T **Goodmanson, Lloyd T.,** Boeing Aircraft Co.
M **Goodwin, R. T.,** Shell Oil Co., Inc.
T **Goran, Lenard A.,** Airplane Div., Curtiss-Wright Corp.
T **Goranson, R. F.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Gordon, Haskell R.,** Navy Dept.
T **Gordon, Lt. Henry Robert,** U.S. Army Corps of Engineers.
I **Gordon, M. B.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Gordon, Marvin J.,** Beech Aircraft Corp.
M **Gordon, Samuel A.,** The Glenn L. Martin Co.
M **Goring, G. R.,** R.C.A.F., Canada.
M **Gorrell, Edgar S.,** Air Transport Association of America.
T **Gorton, R. E.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
M **Gosselin, H. A.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
I **Gott, Edgar N.,** Consolidated Aircraft Corp.
T **Gottlieb, Robert,** Langley Mem. Aero. Lab., N.A.C.A.
F **Gouge, Arthur,** Short Brothers Ltd., England.
F **Gough, Melvin N.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Gough, Ens. W. V., Jr.,** U.S. Navy.
T **Gould, Marcel I.,** Boeing Aircraft of Canada, Ltd., Canada.
I **Gould, Wm. C.,** Allison Div., General Motors Corp.
I **Goulding, Wm. F.,** Export Div., Curtiss-Wright Corp.
T **Graf, Lt. Wm. R.,** U.S. Army.
T **Grafman, A. J.,** Lockheed Aircraft Corp.
M **Graham, Chedo P.,** Airplane Div., Curtiss-Wright Corp.
T **Graham, Donald J.,** Ames Aero. Lab., N.A.C.A.
M **Graham, E. W.,** Douglas Aircraft Co., Inc.
I **Graham, James R.,** U.S. Aviation Underwriters, Inc.
T **Graham, Richard P.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Graham, Capt. Wm. H., Jr.,** U.S. Army Air Forces.
T **Grande, Philip J.,** Lockheed Aircraft Corp.
T **Graninger, Howard J.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
M **Grant, Brig. Gen. David N. W.,** U.S. Army Air Forces.
M **Gray, Capt. Harold E.,** Pan American Airways System.
AF **Gray, Harold E.,** The B. G. Corp.
T **Gray, Wm. E., Jr.,** Langley Mem. Aero. Lab., N.A.C.A.
I **Green, D. C.,** Cleveland Pneumatic Tool Co.; Cleveland Pneumatic Aerol, Inc.
AF **Green, Major F. M.,** R.A.F., England.
AF **Green, Dr. J. J.,** National Research Council, Canada.
T **Green, Wm. T.,** Vega Aircraft Corp.
M **Greene, Col. Carl F.,** U.S. Army Air Forces.
M **Greene, Major Charles C.,** U.S. Army Air Forces.
M **Greene, Dr. Leonard M.,** Grumman Aircraft Eng. Corp.
T **Greene, W. A. C.,** National Steel Car Co. Ltd., Canada.
T **Greener, N. F.,** Defense School of Aeronautics.
T **Greenewald, R. E.,** Bell Aircraft Corp.
T **Greenough, Harrison,** Boeing Aircraft Co.
M **Greenwood, E. J. A., Jr.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Greenwood, Marvin H.,** Boeing Aircraft Co.
M **Greer, Edward M.,** Simmonds Aerocessories, Inc.
T **Greff, Richard M.,** War Dept.
AF **Gregg, David,** Eclipse Aviation Div., Bendix Aviation Corp.
AF **Gregor, Michael,** Consulting Engineer.
M **Gregory, A. T.,** Ranger Aircraft Engines Div., Fairchild Airplane & Engine Corp.
T **Grenzeback, Robert J.,** Mass. Inst. of Tech.
T **Griffin, Bradford, J. P.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Griffith, Lt. Joseph F.,** U.S. Army Air Forces.
M **Grimes, Lt. David L.,** U.S. Army Air Forces.
T **Grimes, Edward K.,** War Dept.
M **Grimes, W. G.,** Grimes Mfg. Co.
T **Grimstad, E. F.,** Goodyear Aircraft Corp.
M **Griswold, Roger W., II,** Pratt, Read & Co.
T **Groben, Philip M.,** Lockheed Aircraft Corp.
T **Gronvold, Walter,** Consolidated Aircraft Corp.

T **Gross, Maynard C.,** Airplane Div., Curtiss-Wright Corp.
I **Gross, Robert E.,** Lockheed Aircraft Corp.
I **Grosvenor, Graham B.,** Pan American Airways System.
T **Grottle, Albert C.,** Pan American Airways System.
T **Grow, Richard L.,** United Air Lines Transport Corp.
T **Grube, Karl P.,** Douglas Aircraft Co., Inc.
T **Grudin, Lt. Daniel,** U.S. Army Air Forces.
F **Grumman, Leroy R.,** Grumman Aircraft Eng. Corp.
T **Gryziecki, Matthew,** Airplane Div., Curtiss-Wright Corp.
M **Guggenheim, Lt. Comdr. Harry F.,** U.S. Navy.
T **Gulick, Beverly G.,** Aircraft Engine Research Lab., N.A.C.A.
T **Gung, Simon F.,** de Havilland Aircraft of Canada, Ltd., Canada.
M **Gureasko, Lt. Edward M.,** U.S. Army Air Forces.
T **Gustafson, Frank Terry,** Boeing Aircraft Co.
T **Gustafson, Frederic B.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Gustilo, Wm. H. A.,** Navy Dept.
T **Guth, Elmer P.,** Waco Aircraft Co.
T **Guthrie, Richard H.,** National Research Council, Canada.
T **Guttmann, Lt. Karl H.,** U.S. Army Air Forces.
T **Guy, Lt. C. Wm.,** U.S. Army Signal Corps.
AF **Gwinn, J. M., Jr.,** Consolidated Aircraft Corp.

T **Haarman, Major Donald W.,** U.S. Army Air Forces.
T **Haber, Bernard D.,** War Dept.
M **Haberlin, John F.,** Boeing Aircraft Co.
M **Habley, C. G.,** Boeing Aircraft Co.
T **Hackenberger, George I., Jr.,** Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.
I **Hagar, Hamilton,** Industry & Security Survey Corp.
T **Hage, Robert E.,** Univ. of Washington.
T **Hagelberg, E. B.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Hahn, S. H.,** Airplane Div., Curtiss-Wright Corp.
M **Haiduck, Andrew F.,** Bellanca Aircraft Corp.
T **Haifter, Capt. Mitchel,** U.S. Army Air Forces.
T **Haig, Chester R., Jr.,** Spartan School of Aeronautics.
M **Haig, F. W.,** Vacuum Oil Co. Pty. Ltd., Australia.
T **Hale, T. E.,** Western Air Lines, Inc.
T **Haley, Lt. S. M.,** U.S. Navy.
F **Hall, A. H.,** England.
I **Hall, Archibald M.,** Consolidated Aircraft Corp.
T **Hall, Burt J.**
T **Hall, C. E.,** Goodyear Aircraft Corp.
M **Hall, Charles L.,** War Dept.
Hall, Delancy M., Harrison Radiator Div., General Motors Corp.
AF **Hall, Donald A.,** Consolidated Aircraft Corp.
T **Hall, Lt. James N.,** U.S. Army Air Forces.
AF **Hall, Capt. Norman B.,** U.S. Coast Guard.
AF **Hall, Randolph F.,** Bell Aircraft Corp.
M **Hall, Robert Arnold,** British Airways Ltd., England.
T **Hall, Robert Atkinson,** Northrop Aircraft, Inc.
AF **Hall, Robert L.,** Grumman Aircraft Eng. Corp.
M **Hall, T. P.,** Consolidated Aircraft Corp.
T **Hall, William D.,** Aeronca Aircraft Corp.
AF **Hallett, Major George E.**
T **Halstead, Paul C.,** Cox & Stevens Aircraft Corp.
M **Hambrook, Dr. Robert W.,** Office of Education, Federal Security Agency.
T **Hamilton, Robert B.,** Lockheed Aircraft Corp.
T **Hamilton, Sam R.,** North Aviation Co.
T **Hamilton, Tonea,** Hughes Aircraft Co.
T **Hamilton, Wm. T.,** Ames Aero. Lab., N.A.C.A.
T **Hamlin, Benson,** Bell Aircraft Corp.
T **Hamm, J. Douglas,** Lockheed Aircraft Corp.
T **Hammarlund, Sidney B.,** Bendix Products Div., Bendix Aviation Corp.
M **Hammen, Theodore F., Jr.,** Ranger Aircraft Engines Div., Fairchild Engine & Airplane Corp.
M **Hamon, A. J. M.,** Navy Dept.
T **Hamsher, John W.,** Airplane Div., Curtiss-Wright Corp.
T **Hankoff, Robert R.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Hanks, Lt. Col. S. S.,** U.S. Army Air Forces.
I **Hannah, Charles C.,** Allison Div., General Motors Corp.
M **Hannam, Frank C.,** Sacramento Junior College.
T **Hannifin, Everett A.,** Boeing Aircraft Co.
AF **Hanscom, C. D.,** Consulting Engineer.
M **Hansen, W. T.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Hanson, A. M., Jr.,** Airplane Div., Curtiss-Wright Corp.
T **Hanson, Hugh L.,** Airplane Div., Curtiss-Wright Corp.
M **Harcum, William M.,** Sperry Gyroscope Co., Inc.
AF **Hardecker, John F.,** Navy Dept.
AF **Harding, John, Jr.,** Harding Devices Co.
T **Harkness, John L.,** McDonnell Aircraft Corp.
AF **Harlow, Max B.,** Pasadena Junior College; Harlow Aircraft Co.
I **Harlow, Robert J.,** Lockheed Aircraft Corp.
T **Harmer, Harold J.,** Bendix Products Div., Bendix Aviation Corp.
M **Harmon, Hubert N.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Harmon, Sidney M.,** Langley Mem. Aero. Lab., N.A.C.A.
AF **Harms, Brig. Gen. Henry W.,** U.S. Army Air Forces.
M **Harney, Pat. J.,** War Dept.
T **Harper, C. W.,** Ames Aero. Lab., N.A.C.A.
T **Harper, John J.,** Georgia School of Tech.
AF **Harpoothian, Edward,** Douglas Aircraft Co., Inc.
AF **Harrington, Dr. R. Paul,** Polytech. Inst. of Brooklyn.
AF **Harris, Col. H. R.,** U.S. Army Air Forces.
M **Harris, Thomas A.,** Langley Mem. Aero. Lab., N.A.C.A.
AF **Harrison, Comdr. Lloyd,** U.S. Navy.
T **Harshman, Jack D.,** Univ. of Washington.
T **Hart, Jack M.,** Platt-LePage Aircraft Corp.
M **Hartenberg, Dr. R. S.,** Northwestern Technological Inst.
T **Hartley, David B.,** Casey Jones School of Aeronautics.
T **Hartley, M. E.,** Boeing Aircraft Co.
I **Hartley, Randolph, Jr.,** War Dept.
M **Hartman, Edwin P.,** N.A.C.A.
M **Hartmann, E. C.,** Aluminum Co. of America.
M **Hartney, H. E.,** Fleetwings, Inc.
M **Hartshorne, Flight Lt. John P. H.,** R.A.F., England.
I **Hartson, J. T.,** The Glenn L. Martin Co.
AF **Hartung, Walter M.,** Casey Jones School of Aeronautics.
AF **Harvey, Emil K.,** Airport Consultant.
T **Harvey, Jacque W.,** Bell Aircraft Corp.
T **Hasegawa, Akira,** Los Angeles Regional Planning Commission.
T **Haselton, W. M.,** The Glenn L. Martin Co.
T **Hasert, Lt. C. N.,** U.S. Army Air Forces.
T **Haskell, C. R.,** Snead & Co.
AF **Haskell, Dr. Raymond,** The Texas Co.
T **Haskins, Robert, Jr.,** Sperry Gyroscope Co., Inc.
T **Hatton, Lt. G. A.**
M **Havens, Lt. Comdr. Beckwith,** U.S. Navy.
T **Havens, Robert F.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Hawkes, Wm. M.,** Navy Dept.
T **Hawkins, Willis M., Jr.,** Lockheed Aircraft Corp.
T **Hawley, Edwin R.**
T **Hayes, Lt. George T.,** U.S. Navy.
T **Hayford, John T.,** Pan American Airways System.
T **Haynes, Alex. L.,** Stinson Aircraft Div., Vultee Aircraft, Inc.
T **Haynes, B. C.,** Safety Bureau, C.A.B.
I **Hays, Russell,** Rotor Research.
M **Hayward, Comdr. J. T.,** U.S. Navy.
F **Hazen, R. M.,** Allison Div., General Motor Corp.
T **Heald, E. R.,** Douglas Aircraft Co., Inc.
AF **Heald, Roy H.,** National Bureau of Standards.

T **Healy, Donald V.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Heath, Frank L.,** Douglas Aircraft Co., Inc.
T **Heath, Westcott, Jr.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Heddleson, Fred,** Westinghouse Electric & Mfg. Co.
F **Hegenberger, Col. A. F.,** U.S. Army Air Forces.
T **Heid, Thomas L.,** Consolidated Aircraft Corp.
T **Height, Lewis H.,** Vega Aircraft Corp.
T **Heimer, Harry J.,** Douglas Aircraft Co., Inc.
AF **Heinemann, E. H.,** Douglas Aircraft Co., Inc.
T **Heinen W. P., Jr.,** Langley Mem. Aero. Lab., N.A.C.A.
AF **Heinrich, Albert S.,** Aeronautical Development.
T **Heldack, John M.,** General Electric Co.
T **Helfman, Sidney,** Koppers Co.
T **Hellert, M. G.,** The Glenn L. Martin Co.
T **Hellman, Stanley C.,** North American Aviation, Inc.
T **Hellsen, Karl,** Lockheed Aircraft Corp.
T **Helmer, Lt. Russell G.,** U.S. Army Corps of Engineers.
T **Helweg, Paul F.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
AF **Hemke, P. E.,** Rensselaer Polytech. Inst.
T **Hendy, F. C.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Henig, Ludwig,** G. M. & L. Henig Corp.
AF **Henrichsen, Knut,** North American Aviation, Inc.
I **Henry, Paul,** C. P. Clare & Co.; Leach Relay Co.
T **Hensel, Lt. Rudolf W.,** U.S. Army Air Forces.
T **Herbert, Fred D., Jr.,** Kearfott Eng. Co.
M **Herlihy, J. A.,** United Air Lines Transport Corp.
T **Herman, David,** Pollak Mfg. Co.
M **Herman, Fred W.,** Douglas Aircraft Co., Inc.
T **Hermes, Raymond F.,** Aeronca Aircraft Corp.
T **Herold, Anthony J.,** War Dept.
F **Heron, S. D.,** Ethyl Corp.
T **Herrala, Carl O.,** Boeing Aircraft Co.
M **Herreshoff, A. G.,** Chrysler Corp.
I **Herrick, Gerard P.,** Herrick Vertoplane Corp.
T **Herron, R. E.,** Lockheed Aircraft Corp.
T **Hersey, Donald S.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
M **Herzog, Adolph,** G & A Aircraft, Inc.
T **Hetzel, E. P.,** Pan American-Grace Airways, Inc., Peru.
M **Heuver, Herbert M.,** War Dept.
I **Hewlett, P. A.,** Vultee Aircraft Inc.
T **Heyduck, L. E., Jr.,** Vultee Aircraft, Inc.
T **Heyl, Edward B.,** C.A.B.
F **Hibbard, Hall L.,** Lockheed Aircraft Corp.
T **Hickey, Whalen K.,** Airplane Div., Curtiss-Wright Corp.
T **Hickman, Clarence J.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
AF **Higginbotham, R. R.,** Republic Aviation Corp.
AF **Higgins, Lt. Comdr. George J.,** U.S. Navy.
T **Hilderbran, Robert L.,** The Glenn L. Martin Co.
I **Hill, F. Leroy,** Aero Screw Co.
M **Hill, H. N.,** Aluminum Co. of America.
T **Hill, Thomas C.,** The Glenn L. Martin Co.
T **Hill, T. Gardner,** The Glenn L. Martin Co.
T **Hilton, Walter B.,** Airplane Div., Curtiss-Wright Corp.
I **Hinckley, Robert H.,** Sperry Corp.
AF **Hingsburg, Comdr. F. C.,** U.S. Coast Guard.
T **Hinton, S. H.,** American Airlines, Inc.
T **Hitch, Robert A.,** The Glenn L. Martin Co.
T **Hittner, Richard,** War Dept.
F **Hobbs, Leonard S.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
M **Hochfeld, Henry,** Eng. & Research Corp.
T **Hockman, Marion T.,** Aero Engine Research Lab., N.A.C.A.
T **Hodder, Earle S.,** Lockheed Aircraft Corp.
T **Hodge, W. R.,** Taylor Engines, Inc.
M **Hodgman, F. S.,** Sperry Gyroscope Co., Inc.
AF **Hodgson, J. E.,** Royal Aeronautical Society, England.
T **Hoernschemeyer, Frank H., Jr.,** Brigg Mfg. Co.
AF **Hoff, Dr. N. J.,** Polytech. Inst. of Brooklyn.
T **Hoffer, Jerome, Jr.,** Duke Univ.
T **Hoffman, Edward J.,** Casey Jones School of Aeronautics.
M **Hoffman, Samuel K.,** The Aviation Corp.
T **Hofweber, A. J.,** General Motors Corp.
T **Hoggard, H. Page, Jr.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Hoistad, A. O.,** Lockheed Aircraft Corp.
M **Hokanson, E. C.,** Whiting Corp.
T **Holback, George E.,** The Glenn L. Martin Co.
M **Holbrook, D. L.,** Fafnir Bearing Co.
AF **Holland, Maurice,** National Research Council.
M **Hollerith, Charles,** Hayes Industries, Inc.
M **Holmes, Bradford B.,** Pioneer Instrument Div., Bendix Aviation Corp.
T **Holmes, Lt. W. C., Jr.,** U.S. Navy.
T **Holmes, William S.,** Airplane Div., Curtiss-Wright Corp.
T **Holt, Lt. Jack,** U.S. Army Air Forces.
M **Holt, Oscar E. F.,** Airplane Div., Curtiss-Wright Corp.
T **Holtan, Lester C.,** Western Air Lines, Inc.
T **Holtzclaw, Ralph W.,** Ames Aero. Lab., N.A.C.A.
T **Hong, Jim,** Fletcher Aviation Corp.
T **Honikel, G. F., Jr.,** Grumman Aircraft Eng. Corp.
T **Hood, D. W.,** Airplane Div., Curtiss-Wright Corp.
T **Hood, Gordon K., Jr.,** Bell Aircraft Corp.
M **Hood, Manley J.,** Ames Aero. Lab., N.A.C.A.
T **Hook, F. L.,** The Glenn L. Martin Co.
T **Hookway, R. O.,** The Glenn L. Martin Co.
M **Hoover, W. S.,** Canadian Car & Foundry Co., Ltd., Canada.
M **Hopkins, Wm. R.,** Lycoming Div., The Aviation Corp.
I **Horchler, Bennett H.,** Institute of the Aeronautical Sciences.
T **Horkey, E. J.,** North American Aviation, Inc.
T **Horn, Bernard R.,** Airplane Div., Curtiss-Wright Corp.
M **Horn, H. Tory,** Boeing Aircraft Co.
T **Horning, W. F.,** Lockheed Aircraft Corp.
M **Horrisberger, John F.,** Navy Dept.
T **Horton, Claude L.,** C.A.A.
T **Horton, Roger F.,** Dowty Equipment Corp.
T **Horwath, Albert S.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
M **Hospers, John J.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Hotchkiss, Henry G.,** U.S. Aviation Reports.
T **Hotson, John H.,** Dominion Skyways Ltd., Canada.
T **Hotz, Harry E.,** Airplane Div., Curtiss-Wright Corp.
T **Houck, Roy M.,** Airplane Div., Curtiss-Wright Corp.
AF **Houghton, Howard D.,** Douglas Aircraft Co., Inc.
M **House, F. R.,** Sperry Gyroscope Co., Inc.
T **House, Wm. C.,** Navy Dept.
T **Houser, Jacque,** Alabama Polytech. Inst.
T **Houston, Robert R., Jr.,** Pan American Airways System.
AF **Hovgaard, Paul Edgar,** The Glenn L. Martin Co.
F **Hovgaard, Dr. William,** Prof. Emeritus, Mass. Inst. of Tech.
M **Howard, H. B.,** British Air Commission.
T **Howard, J. R.,** Pan American Airways System.
T **Howard, Lt. Walter B., Jr.,** U.S. Army Air Forces.
T **Howard, William C.,** Virginia Polytech. Inst.
T **Howland, Daniel,** Pan American Airways System.
T **Howland, Dr. W. Lavern,** Lockheed Aircraft Corp.
T **Hu, Seng Chin,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Hu, Shu-Kwang,** China.
T **Hubbard, John D.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.

T **Huber, J. Richard,** G & A Aircraft, Inc.
AF **Hubner, W. H.,** Ethyl Corp.
T **Huether, Robert W.,** Lockheed Aircraft Corp.
AF **Huff, Thomas H.,** Brasco Mfg. Co.
M **Hufferd, George H.,** Houdaille-Hershey Corp.
T **Hughes, Lt. Charles S.,** U.S. Marine Corps.
T **Hughes, Eugene H.,** Lockheed Aircraft Corp.
T **Hughes, George W., Jr.,** Consolidated Aircraft Corp.
M **Hughes, Howard R.,** Hughes Aircraft Co.
T **Hughey, A. H.,** Douglas Aircraft Co., Inc.
T **Huisman, George R.,** North American Aviation, Inc.
AF **Hull, Harvard L.,** York Safe & Lock Co.
T **Hull, Lewis W.,** Fleetcraft Corp.
AF **Hull, Dr. Lewis M.,** Aircraft Radio Corp.
M **Hulse, Barton T.,** Airplane Div., Curtiss-Wright Corp.
AF **Hume, Sqdn. Ldr. D. C. M.,** R.C.A.F., Canada.
I **Humphery, G. E. Woods.**
T **Humphrey, Wm. V.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Hunnex, Milton D.,** Cal-Aero Corp.
HF **Hunsaker, Dr. J. C.,** Mass. Inst. of Tech.; N.A.C.A.
T **Hunt, Donald C.,** General Motors Corp.; Lawrence Inst. of Tech.; Detroit Inst. of Tech.
T **Hunter, David U.,** Lawrance Eng. & Research Corp.
T **Hunter, Wm. T.,** Archmere, Inc.
M **Hunter, Willson H.,** B. F. Goodrich Co.
T **Hunton, Fred W.,** Mass. Inst. of Tech.
T **Huppert, Merle C.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Hurty, Walter C.,** Vega Aircraft Corp.
M **Huss, Dr. P. O.,** Guggenheim Airship Inst.
M **Hutchinson, Prof. F. W.,** Univ. of California.
M **Hutchinson, L. B.,** Brewster Aeronautical Corp.
M **Hutton, Richard,** Grumman Aircraft Eng. Corp.
T **Hutzler, Ens. R. H.,** U.S. Navy.

AF **Ide, Lt. Comdr. John J.,** U.S. Navy.
T **Ill, Edward J.,** Orange Screen Co.
T **Immenschuh, William T.,** Ryan Aeronautical Co.
M **Inglish, H. C.,** Vega Aircraft Corp.
T **Innes, Charles B., Jr.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
F **Insley, Robert,** Kinner Motors, Inc.
I **Ireland, G. S.**
T **Irving, Lt. David E.,** U.S. Army Air Forces.
I **Isaacs, R. H.,** Pioneer Instrument Div., Bendix Aviation Corp.
T **Isen, Sidney,** Duramold Aircraft Corp. Div., Fairchild Engine & Airplane Corp.
T **Israel, Edmund M.,** Lockheed Aircraft Corp.
T **Israel, Marion S.,** Douglas Aircraft Co., Inc.
T **Isreeli, Jack,** Brewster Aeronautical Corp.
T **Iszard, Robert F.,** General Electric Co.
T **Ivanovic, Nicholas,** Navy Dept.

M **Jackson, Major D. C., Jr.,** U.S. Army.
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M **Jacob, John B.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
AF **Jacobs, Albert R.,** Jacobs Aircraft Engine Co.
F **Jacobs, Eastman,** Langley Mem. Aero. Lab., N.A.C.A.
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AF **Jacobson, Joel M.,** Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.
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T **Jaeger, Julius A.,** Lockheed Aircraft Corp.
AF **Jakosky, Major Milton,** U.S. Army Air Forces.
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T **James, Heighton D.,** War Dept.
M **Jamouneau, Walter C.,** Piper Aircraft Corp.
T **Jarosh, S. E.,** Westinghouse Electric & Mfg. Co.
T **Jarrett, Alfred L.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Jean, James E.,** Lockheed Aircraft Corp.
T **Jedeka, L. W.,** Lockheed Aircraft Corp.
AF **Jeffries, Dr. Zay,** General Electric Co.; Aluminum Co. of America.
M **Jenkins, Edward S.,** Airplane Div., Curtiss-Wright Corp.
M **Jenkins, Lt. Comdr. John G.,** National Research Council; Navy Dept.; Univ. of Maryland.
M **Jenny, Cletus J.,** Eclipse Aviation Div., Bendix Aviation Corp.
T **Jensen, E. William, Jr.,** Boeing Aircraft Co.
T **Jensen, Harry T.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Jerome, Lt. Col. Clayton C.,** U.S. Marine Corps.
AF **Jessen, Prof. Henry,** Stanford Univ.
T **Jewett, Charles S.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
M **Jewett, Frederic D.,** The Glenn L. Martin Co.
T **Joanides, Jack C.,** Murray Corp. of America.
T **Jobes, Lt. Harry W.,** U.S. Army.
I **Johns, R. C.,** *Aero Digest* and *Revista Aerea* magazines.
T **Johnson, Arlo F.,** Douglas Aircraft Co., Inc.
AF **Johnson, Carl V.,** Bendix Products Div., Bendix Aviation Corp.
AF **Johnson, Clarence L.,** Lockheed Aircraft Corp.
T **Johnson, Clyde B., Jr.,** Douglas Aircraft Co., Inc.
I **Johnson, E. E.,** General Electric Co.
T **Johnson, Harold I.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Johnson, H. W.,** Briggs Mfg. Co.
T **Johnson, Irving A.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Johnson, J. Osborn,** North American Aviation, Inc.
T **Johnson, Paul A.,** Boeing Aircraft Co.
M **Johnson, Philip G.,** Boeing Aircraft Co.
T **Johnson, Philip O.,** General Motors Corp.
AF **Johnson, Robert E.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Johnson, Waldon T.,** Douglas Aircraft Co., Inc.
T **Johnson, Walter C.,** United Air Lines Transport Corp.
T **Johnson, William A., Jr.,** Lockheed Aircraft Corp.
M **Johnston, Robert B.,** Ryan Aeronautical Co.
AF **Johnston, S. Paul,** Curtiss-Wright Corp.
T **Joiner, Ernest L., Jr.,** Lockheed Aircraft Corp.
T **Jonas, Julius,** Beech Aircraft Corp.
HF **Jones, Sir Melvill,** Cambridge Univ., England.
AF **Jones, Prof. Bradley,** Univ. of Cincinnati.
M **Jones, C. S.,** Casey Jones School of Aeronautics.
T **Jones, Charles H., Jr.,** Airplane Div., Curtiss-Wright Corp.
T **Jones, Lester C.,** Lockheed Aircraft Corp.
T **Jones, Ray S.,** North American Aviation, Inc.
M **Jones, Robert T.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Jones, Prof. Vern,** Tri-State College.
AF **Jones, Walter R.,** Lockheed Aircraft Corp.
T **Jong, Howard W.,** Douglas Aircraft Co., Inc.
T **Jongeneel, James W.,** Douglas Aircraft Co., Inc.
T **Jordan, Donald J.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
I **Jordanoff, Assen,** Jordanoff Aviation Co.
T **Jordan, Henry F., Jr.,** Cleveland Pneumatic Tool Co.
I **Joseph, Franklin H.,** Sperry Gyroscope Co., Inc.
T **Josephs, Lyman C., III,** Trojan Powder Co.
M **Jouett, John H.,** Aeronautical Chamber of Commerce of America.
T **Jue, George,** The Zap Corp.
T **Jungemann, Wm. C.,** Consolidated Aircraft Corp.
T **Just, Theodore R.,** Douglas Aircraft Co., Inc.

T **Kadushin, Jacob,** Lockheed Aircraft Corp.
T **Kaganov, Benjamin J.,** Goodyear Aircraft Corp.
T **Kahlke, Charles E., Jr.,** The Glenn L. Martin Co.

M **Kahn, Roger Wolfe,** Civil Air Patrol.
M **Kalinowski, Ludwig B.,** Edo Aircraft Corp.
M **Kallis, Felix,** Bell Aircraft Corp.
T **Kaman, Charles H.,** Hamilton Standard Propellers Div., United Aircraft Corp.
T **Kamm, Robert W.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Kane, Robert F.,** Pan American Airways System.
T **Kann, Wm. H.,** Boeing Aircraft Co.
T **Kantner, Leslie C., Jr.,** Lockheed Aircraft Corp.
T **Kantor, Maxwell,** Skydyne, Inc.
T **Kantrow, Harold,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
AF **Kaplan, Dr. Carl,** Langley Mem. Aero. Lab., N.A.C.A.
T **Kaplan, Edward,** Consolidated Aircraft Corp.
I **Karant, Max,** *Flying and Popular Aviation* Magazine.
T **Karstens, Nicholas V.,** Douglas Aircraft Co., Inc.
M **Kass, George,** Republic Aviation Corp.
I **Kassler, Charles M., Jr.,** Douglas Aircraft Co., Inc.
T **Kastan, Howard,** Lockheed Aircraft Corp.
T **Kather, Paul,** Boeing Aircraft Co.
T **Katzenberger, Edward F.,** Brewster Aeronautical Corp.
T **Kauffman, N. N.,** Vultee Aircraft Co.
T **Kaufman, Ben,** Luscombe Airplane Corp.
T **Kaufman, Harold,** Navy Dept.
T **Kavanaugh, Edward S.,** Univ. of Notre Dame.
T **Kayten, Gerald G.,** Langley Mem. Aero. Lab., N.A.C.A.
AF **Kean, John S.,** Navy Dept.
I **Kearney, Joseph N.,** Defendaire Corp.
M **Kearns, Charles M., Jr.,** Hamilton Standard Propellers Div., United Aircraft Corp.
T **Kellam, A. M.,** Lockheed Aircraft Corp.
I **Kellett, R. G.,** Kellett Autogiro Corp.
I **Kellett, W. Wallace,** Republic Aviation Corp.; Kellett Autogiro Corp.
T **Kelley, Lt. Joseph, Jr.,** U.S. Army Air Forces.
M **Kelly, Dr. E. Lowell,** Purdue Univ.
M **Kelly, Frederick G.,** Thomas A. Edison, Inc.
T **Kelly, Lt. Patrick L.,** U.S. Army Air Forces.
M **Kelly, Thomas N.,** Vultee Aircraft, Inc.
F **Kemmer, Col. Paul H.,** U.S. Army Air Forces.
I **Kemp, A. N.,** American Airlines, Inc.
T **Kemp, William B., Jr.,** Langley Mem. Aero. Lab., N.A.C.A.
AF **Kemper, Carlton,** Langley Mem. Aero. Lab., N.A.C.A.
T **Kendrick, James B.,** Vega Aircraft Corp.
T **Kenger, Arthur,** Airplane Div., Curtiss-Wright Corp.
I **Kennedy, W. D.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
M **Kennedy, W. P.,** Airplane Div., Curtiss-Wright Corp.
M **Kenyon, Ralph W.,** C.A.A.
M **Kerr, Henry H.,** Weatherhead Co.
M **Kibardin, Victor M.,** Airplane Div., Curtiss-Wright Corp.
T **Kieckhefer, Thomas F.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Kiefer, Eugene P.,** War Dept.
T **Kiehle, Marlin H.,** Airplane Div., Curtiss-Wright Corp.
T **Kieran, W. P.,** Noorduyn Aviation Ltd., Canada.
T **Kieser, Frank B.,** Navy Dept.
T **Kiester, H. T.,** Pan American Airways System.
M **Killian, Joseph P.,** Eastern Aircraft Div., General Motors Corp.
F **Kimball, Dr. James H.,** U.S. Weather Bureau.
T **Kincaid, Frank M., Jr.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
F **Kindelberger, J. H.,** North American Aviation, Inc.
T **King, Douglas A.,** Langley Mem. Aero. Lab., N.A.C.A.
T **King, Robert W.,** Dow Chemical Co.
M **Kinnucan, James W.,** Continental Motors Corp.
M **Kinsey, Robert S.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
M **Kintzer, Nicholas D.,** Acad. of Aeronautics.
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AF **Kirchner, Otto E.,** American Airlines, Inc.
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T **Kirk, Randall W.,** Pan American Air Ferries.
T **Kirkpatrick, Lt. R. J.,** U.S. Army Air Forces.
AF **Kirsten, Prof. F. K.,** Univ. of Washington.
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AF **Klein, Dr. A. L.,** Calif. Inst. of Tech.; Douglas Aircraft Co., Inc.
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M **Klenke, Major W. H., Jr.,** U.S. Marine Corps.
T **Kleven, Walter H.,** Lockheed Aircraft Corp.
AF **Klikoff, W. A.,** C.A.A.
M **Klose, A. J.,** Vultee Aircraft, Inc.
M **Klotz, J. Charles,** Univ. of Tulsa.
T **Kluga, Edwin C.,** Airplane Div., Curtiss-Wright Corp.
M **Knabenshue, Roy,** Dept. of the Interior.
AF **Knack, Frederick J.,** G & A Aircraft, Inc.
T **Knecht, Robert S.,** Navy Dept.
T **Knerr, Lewis E., Jr.,** Pan American Airways System.
T **Knies, Walter J.,** Pan American Airways System.
T **Knight, Art R.,** Lockheed Aircraft Corp.
AF **Knight, Prof. Montgomery,** Georgia School of Tech.
T **Knoblock, F. D.,** Thornton Tandem Co.
M **Knoll, Lt. Comdr. Denys W.,** U.S. Navy.
T **Knowles, Richard C.,** Sperry Gyroscope Co., Inc.
AF **Knowles, Thomas A.,** Goodyear Aircraft Corp.
T **Knox, Charles B.,** Wind Tunnel Research, Hawaii.
M **Knox, Thomas,** Fleetwings, Inc.
T **Koch, George,** Airplane Div., Curtiss-Wright Corp.
M **Koch, Walter L.,** Cornell Univ.
M **Kocher, Addis E.,** Eclipse Aviation Div., Bendix Aviation Corp.
M **Koegler, Richard K.,** Airplane Div., Curtiss-Wright Corp.
T **Koellish, Wilfred M.,** The Glenn L. Martin Co.
T **Koenig, Edward L.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Kohr, Bradley G.,** Parks Air College, Inc.
M **Kolehmainen, Leo,** Northrop Aircraft, Inc.
F **Kollsman, Paul,** Kollsman Instrument Div., Square D Co.
M **Komarnitsky, R. S.,** Standard Steel Spring Co.
T **Koon, Charles A.,** Boeing Aircraft Co.
F **Koppen, Otto C.,** Mass. Inst. of Tech.; General Aircraft Corp.
T **Kopplin, Carl H.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Korbin, Ernest,** The Glenn L. Martin Co.
T **Kordenbrock, Lt. James U.,** U.S Army Air Forces.
M **Koriagin, V. B.,** Lockheed Aircraft Corp.
T **Korody, Paul C.,** Airplane Div., Curtiss-Wright Corp.
M **Korsak, Kazimierz,** de Havilland Aircraft of Canada, Ltd.,Canada.
T **Korstian, Robert J.,** Grumman Aircraft Eng. Corp.
AF **Korvin-Kroukovsky, B. V.,** Edo Aircraft Corp.
M **Kossler, Comdr. Wm. J.,** U.S. Coast Guard.
AF **Kotcher, Ezra,** War Dept.
T **Kotowski, Bruno,** Murray Corp. of America.
T **Kottke, H. Garon,** Goodyear Aircraft Corp.
AF **Kousnetzoff, Valerien P.,** Waco Aircraft Co.
M **Kramer, C. Raymond,** Brewster Aeronautical Corp.
T **Kramer, Edward H.,** War Dept.
M **Kramer, Fred S.,** Consolidated Aircraft Corp.
T **Krasnitski, John,** Casey Jones School of Aeronautics.

F **Kraus, Rear Admiral S. M.,** U.S. Navy.
T **Krause, Walter J.,** Cessna Aircraft Co.
T **Kraushar, Lt. Philip G.,** U.S. Army Air Forces.
T **Kreidler, Frank G.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Kreisler, S. S.,** Douglas Aircraft Co., Inc.
T **Kreitinger, Richard L.,** Boeing Aircraft Co.
T **Kreitzberg, G. F.,** McDonnell Aircraft Corp.
AF **Krenz, E. J.,** Boeing School of Aeronautics.
AF **Kreusser, Otto T.,** Allison Div., General Motors Corp.
T **Krieger, Stuart A.,** Northrop Aircraft, Inc.
M **Krivetsky, Alexander,** Airplane Div., Curtiss-Wright Corp.
T **Kroening, George, Jr.,** Airplane Div., Curtiss-Wright Corp.
T **Krug, Lt. John W.,** U.S. Army.
T **Krzymowski, Walter,** The Glenn L. Martin Co.
AF **Krzywoblocki, Dipl. Ing. M. Z.,** Noorduyn Aviation Ltd., Canada.
T **Kueck, Herbert F.,** Beech Aircraft Corp.
AF **Kuethe, Dr. A. M.,** Univ. of Michigan.
T **Kuhrt, Wesley A.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Kujawa, Lt. Leo J.,** U.S. Army Air Forces.
T **Kuns, Harold J.,** Waco Aircraft Co.
AF **Kurt, Franklin T.,** Grumman Aircraft Eng. Corp.
T **Kurzawa, Edward,** Consolidated Aircraft Corp.
T **Kutsay, A. U.,** The Pennsylvania State College.
M **Kuyper, William W.,** General Electric Co.
T **Kyropoulos, Peter,** Calif. Inst. of Tech.

AF **Labensky, Boris P.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Lacker, Robert J.,** Airplane Div., Curtiss-Wright Corp.
T **La Clare, Lt. Edward F.,** U.S. Army Air Forces.
T **LaClair, Harold Z.,** Willys Overland Motors, Inc.
F **Laddon, I. Machlin,** Consolidated Aircraft Corp.
M **Lahm, Brig. Gen. Frank P.,** U.S. Army (Ret.).
T **Laitone, Edmund V.,** Ames Aero. Lab., N.A.C.A.
I **Lake, Harley W.,** Socony-Vacuum Oil Co.
T **Lamar, Lt. William E.,** U.S. Army Air Forces.
T **Lamb, Orion C.,** Lockheed Aircraft Corp.
M **LaMont, James B.,** Northwest Airlines, Inc.
T **Lamont, Lt. Neil, Jr.,** U.S. Army Air Forces.
M **Lamplugh, Alfred G.,** British Aviation Insurance Co. Ltd., England.
T **Lamson, Robert T.,** Boeing Aircraft Co.
F **Lanchester, F. W.,** Consulting Engineer, England.
F **Land, Rear Admiral Emory S.,** U.S. Navy (Ret.); U.S. Maritime Commission.
T **Land, Norman S.,** Langley Mem. Aero. Lab., N.A.C.A.
B **Landauer, Bella C.,** Aeronautical Archives.
T **Landis, Merle A.**
M **Landis, Reed G.,** Chicago Aeronautics Commission; American Airlines, Inc.
AF **Lane, Kenneth M.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
M **Lane, Paul S.,** Muskegon Piston Ring Co.
T **Lane, Winford J.,** Lockheed Aircraft Corp.
AF **Lange, Dr. Karl O.,** Blue Hill Observatory, Harvard Univ.
M **Langley, Marcus,** Flight Refuelling Ltd., England.
T **Langmore, Herbert C.,** Ford Motor Co.
T **Langon, Roberto M.,** Direction of Civil Aeronautics, Uruguay.
T **Lankford, Eugene, Jr.,** Lockheed Aircraft Corp.
AF **Lansing, Raymond P.,** Bendix Aviation Corp.
T **Lapinski, Lucian S.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Lappin, Arthur N.,** Airplane Div., Curtiss-Wright Corp.
M **Larner, Col. G. deFreest,** U.S. Army Air Forces.
T **LaRosa, Salvatore,** Snead & Co.
AF **Larsen, Agnew E.,** Machine & Tool Designing Co.
T **Larsen, Alvin C.,** Boeing Aircraft Co.
T **Larsen, Harold R.,** W. & L. E. Gurley.
M **Larsen, Victor A.,** Vega Aircraft Corp.
AF **Larson, C. M.,** Sinclair Refining Co.
T **Larson, Leonard,** Northrop Aircraft, Inc.
T **Larson, Lorell V.**
M **Larson, Norman F.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
M **Larson, Oscar T.,** Trans-Canada Airlines, Canada.
AF **La Sha, Stanley S.,** Bell Aircraft Corp.
T **Lasher, Charles W.,** Airplane Div., Curtiss-Wright Corp.
AF **Lathrem, Charles I.,** Canadian Car & Foundry Co. Ltd., Canada.
M **Lau, Alfred H.,** Airplane Div., Curtiss-Wright Corp.
M **Laubenfels, Major C. R.,** U.S. Army Air Forces.
T **Laule, Gerald,** Lockheed Aircraft Corp.
F **Lawrance, Charles L.,** Lawrance Eng. & Research Corp.
T **Lawrance, Ray,** England.
M **Lawrence, Herbert R.,** Northrop Aircraft, Inc.
T **Laws, Lt. John S.,** U.S. Army Air Forces.
T **Lawson, Kenneth V.,** Consolidated Aircraft Corp.
T **Lawton, John W.,** U.S. Army Air Forces.
I **Lea, Robert B.,** Sperry Gyroscope Co., Inc.
AF **Leak, Arthur H.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
M **Lear, William P.,** Lear Avia, Inc.; Lear Avia of Calif., Inc.
T **LeBeck, Lt. Robert K.,** U.S. Army Air Forces.
T **Lecavalier, J. Fernand,** National Research Council, Canada.
T **Ledbetter, Girvis E.,** Airplane Div., Curtiss-Wright Corp.
AF **Lederer, Jerome,** Airlines War Training Inst.
T **Lee, Harry P.,** Universal Moulded Products Corp.
T **Lee, James W.,** Bell Aircraft Corp.
AF **Lee, John G.,** United Aircraft Corp.
T **Lee, Joseph C.,** American Airlines, Inc.
T **Lee, Kam Fong,** Vulcan Steel Foundry; Glenn-Roberts Arc Welder Machine Co.
T **Lee, Sherman H.,** Waco Aircraft Co.
T **Lee, Tom A.,** North American Aviation, Inc.
T **Lehman, Frederick,** Propeller Div., Curtiss-Wright Corp.
T **Leich, Lt. Harvey A.,** U.S. Marine Corps.
AF **Leighton, Bruce G.,** Intercontinent Corp.; Intercontinent Aircraft Co.
T **Leiserson, Charles F.,** U.S. Navy.
AF **Leisy, Clifford J.,** Vega Aircraft Co.
M **Lemonier, Camille R.,** Airplane Div., Curtiss-Wright Corp.
T **Lemont, Harold E.,** Grumman Aircraft Eng. Corp.
T **Lentz, George L.,** General Electric Co.
T **Lentz, Ralph G.,** Allied Aircraft Corp.
M **Leonard, N. Nelson,** Douglas Aircraft Co., Inc.
T **Leonard, Stephen R.,** Oneida, Ltd.
AF **LePage, W. Laurence,** Platt-LePage Aircraft Co.
T **Leppert, Elmer L., Jr.,** Lockheed Aircraft Corp.
T **Le Roy, Warren H.,** Spartan School of Aeronautics.
T **Lesher, Edgar.** A. & M. College of Texas.
AF **Leslie, John C.,** Pan American Airways System.
T **Lessard, Roy W.,** Airplane Div., Curtiss-Wright Corp.
T **Lesser, Murray L.,** Northrop Aircraft, Inc.
AF **Lester, Everard M.,** Ranger Aircraft Engines Div., Fairchild Engine & Airplane Corp.
T **Letko, William,** Langley Mem. Aero. Lab., N.A.C.A.
T **Leuang, William A.,** Eastern Aircraft Div., General Motors Corp.
T **Leutloff, Wayne E.,** Ryan Aeronautical Co.
T **Levin, Daniel H.,** Consolidated Aircraft Corp.
T **Levine, Aaron,** Stevens Inst. of Tech.

T **Levine, Arnold,** U.S. Army Air Forces.
T **Levine, Ralph,** G & A Aircraft, Inc.
T **Levy, Charles N.,** Timm Aircraft Co.
M **Levy, G. S.,** National Research Council, Canada.
T **Lewand, Franklin,** Vultee Aircraft, Inc.
T **Lewis, Bennett,** Lockheed Aircraft Corp.
T **Lewis, David,** Vultee Aircraft, Inc.
HF **Lewis, Dr. George W.,** N.A.C.A.
T **Lewis, Richard B.,** Pan American-Grace Airways, Inc., Peru.
T **Lewis, Robert C.,** Lockheed Aircraft Corp.
T **Libby, Charles J.,** Edo Aircraft Corp.
T **Libby, Paul A.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Liberatore, Eugene K.,** Navy Dept.
I **Lieber, Francis,** All American Aviation Corp.
T **Lief, Milton,** Airplane Div., Curtiss-Wright Corp.
T **Liepmann, Hans P.,** Univ. of Cincinnati.
T **Light, Gordon S.,** The Glenn L. Martin Co.
T **Light, James A.,** Pioneer Instrument Div., Bendix Aviation Corp.
T **Light, Russell B.,** Boeing Aircraft Co.
M **Lightfoot, Ralph B.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
AF **Liljencrantz, Comdr. Eric,** U.S. Navy.
T **Lilligren, Robert W.,** Lockheed Aircraft Corp.
T **Lim, On Wah,** Aircraft Repair Ltd., Canada.
T **Lina, Lindsay J.,** Langley Mem. Aero. Lab., N.A.C.A.
F **Lindbergh, Charles A.,** Ford Motor Co.
T **Lindblad, Herbert,** Brewster Aeronautical Corp.
T **Lindquist, Bertil H. T.,** Research Laboratories Div., General Motors Corp.
I **Lindsay, K. S.,** The B. G. Corp.
T **Lindstrom, R. G.,** The Glenn L. Martin Co.
T **Linklater, G. Donald,** Northwest Airlines, Inc.
T **Lister, Robert E., Jr.,** Delehanty Inst.
I **Litchfield, Burnham,** Duramold Aircraft Corp. Div., Fairchild Engine & Airplane Corp.
I **Litchfield, Paul W.,** Goodyear Tire & Rubber Co.; Goodyear Aircraft Corp.
M **Littell, Robert E.,** N.A.C.A.
AF **Little, Delbert M.,** U.S. Weather Bureau.
M **Little, Lt. David S.,** U.S. Navy.
F **Littlewood, William,** American Airlines, Inc.
T **Lobel, Seymour Z.,** Brewster Aeronautical Corp.
M **Lockridge, Lloyd P.,** Sinclair Refining Co.
AF **Locke, Arthur A.,** Wayne Univ.
M **Locke, Frederick W. S., Jr.,** Stevens Inst. of Tech.
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F **Loening, Grover,** W.P.B.; Consulting Engineer.
I **Loening, Rudolph R.,** Attorney.
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T **Logan, Daniel A., Jr.**
T **Logan, John M.,** Lord Mfg. Co.
T **Lohr, Carl T.,** McDonnell Aircraft Corp.
AF **Lombard, Albert E., Jr.,** W.P.B.; Joint Aircraft Committee.
M **Lombardi, Loreto,** Airplane Div., Curtiss-Wright Corp.
T **Longden, John L.,** R.A.F., England.
T **Longfelder, Harlowe J.,** Boeing Aircraft Co.
M **Loomis, Robert C.,** Transcontinental & Western Air, Inc.
T **Lorenz, Sigmund J.,** The Glenn L. Martin Co.
M **Loring, Samuel J.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
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M **Lott, E. P.,** United Air Lines Transport Corp.
AF **Louden, Frederic A.,** Navy Dept.
AF **Loudenslager, O. W.,** Goodyear Aircraft Corp.
AF **Loudy, F. E.,** Navy Dept.
T **Louie, James,** Univ. of Washington.
AF **Lovelace, Major W. Randolph, II,** U.S. Army Medical Corps.
T **Lovett, Lt. Comdr. Benjamin B. C.,** U.S. Navy.
HM **Lovett, Hon. Robert A.,** War Dept.
T **Lowell, Lt. Arthur L.,** U.S. Army Air Forces.
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AF **Luburg, Guy A.,** Brewster Aeronautical Corp.
M **Lucas, Major Philip D.,** U.S. Army Air Forces.
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T **Luethi, Lt. Comdr. Carl F.,** U.S. Navy.
AF **Lunde, Lt. Otto H.,** U.S. Navy.
M **Lundgren, Agne,** Vega Aircraft Corp.
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T **Lusty, Cameron N.,** Mercury Aircraft Corp.
M **Luther, John M.,** Globe Aircraft Corp.
T **Lutostanski, Matthew G.**
M **Luttman, H. C.,** British Air Commission, England.
M **Lutton, Lyle S.,** St. Louis Aircraft Corp.
T **Luttrell, John C.,** War Dept.
I **Lutz, Frederick W.,** W. L. Maxson Corp.
T **Lutz, Robert J.,** Consolidated Aircraft Corp.
M **Lyman, Charles B.,** Navy Dept.
M **Lyman, Joseph,** Sperry Gyroscope Co., Inc.
T **Lynahan, Paul W.,** Fleetwings, Inc.
AF **Lynam, F. C.,** Airscrew Co. Ltd., England.
T **Lynn, Norman,** Douglas Aircraft Co., Inc.
T **Lynt, Herbert E.,** U.S. Navy.

T **Macauley, Clinton B. F.,** *Aviation* Magazine.
F **MacCart, Comdr. Raymond D.,** Brewster Aeronautical Corp.
AF **MacClain, A. Lewis,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
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M **Mackenzie, N. J. G.,** National Steel Car Corp. Ltd., Canada.
M **MacLean, John A.,** Bendix Products Div., Bendix Aviation Corp.
M **MacNeil, Charles S. J.,** Aeroproducts Div., General Motors Corp.
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AF **Majneri, Ludwig A.,** Warner Aircraft Corp.
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T **Malkiewicz, W. F.,** Brewster Aeronautical Corp.
I **Malkovsky, Louis,** Sperry Gyroscope Co., Inc.
T **Maller, Monroe A.,** Consolidated Aircraft Corp.

I **Mallon, William H.,** Industrial Engineer.
M **Malmsten, Lee R.,** Univ. of Miami.
T **Malmstrom, Herbert L.,** Douglas Aircraft Co., Inc.
T **Maloney, J. Francis,** The Glenn L. Martin Co.
T **Maloney, Philip R.,** Consolidated Aircraft Corp.
M **Maloy, Raymond B.,** C.A.A.
T **Mandel, M. W.,** Langley Mem. Aero. Lab., N.A.C.A.
AF **Mandolf, I. H.,** Consolidated Aircraft Corp.
M **Mangurian, George N.,** The Glenn L. Martin Co.
T **Mannick, Philip R.,** Vultee Aircraft, Inc.
T **Manuel, Hermogenes S.,** Francisco & Jacobus.
T **Mar, James,** Curtiss-Wright Corp.
T **Marble, Frank E.,** Case School of Applied Science.
T **March, Lt. Paul H.,** U.S. Army Air Forces.
T **Marchetti, Robert M.,** The Glenn L. Martin Co.
T **Marchi, Bruno P.,** U.S. Army.
I **Marcus, Charles,** Bendix Aviation Corp.
T **Marcus, Woodrow C.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
M **Markey, Richard J.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
AF **Markey, Roscoe I.,** Pollak Mfg. Co.
AF **Markham, Prof. John R.,** Mass. Inst. of Tech.
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T **Markowitz, Jesse,** College of the City of New York.
M **Marks, J. David,** The Bolton Mfg. Co.
T **Marks, John L.,** Allison Div., General Motors Corp.
T **Marks, Paul Gene,** Vega Aircraft Corp.
T **Marmentini, Lt. Enzo G.,** Chilean Air Force.
F **Marsh, Lt. Col. W. Lockwood,** *Aircraft Engineering* Magazine, England.
T **Martin, Lt. Dean E.,** U.S. Army.
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T **Martin, Lt. Thomas J.,** U.S. Army Air Forces.
M **Martin, Victor J.,** A. & M. College of Texas.
M **Martin, Wilbur A.,** Grumman Aircraft Eng. Corp.
I **Mascuch, Joseph J.,** Breeze Corporations, Inc.
M **Maser, E. E.,** Louisiana State Univ.
M **Mashbir, Lt. Col. Sidney F.,** U.S. Army.
T **Maske, Lt. Edmund B., Jr.,** U.S. Army.
M **Masland, William M.,** Pan American Airways System.
T **Mason, Lt. Walter E.,** U.S. Army.
M **Masterson, Byron B.,** Lockheed Aircraft Corp.
T **Mastrocola, Nicholas,** Langley Mem. Aero. Lab., N.A.C.A.
M **Mathes, John C.,** Dow Chemical Co.
T **Mathews, Charles E.,** Transportes Aereos Centro Americanos, S.A., Honduras.
T **Mattern, Calvert M.,** Boeing Aircraft Co.
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T **Mattila, A. J.,** Boeing Aircraft Co.
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M **Mautner, Etienne,** Skydyne, Inc.
T **Maxam, Frederick A.,** Airplane Div., Curtiss-Wright Corp.
M **Maxson, Capt. Lisle J.,** U.S. Navy.
T **Maxwell, Lt. Robert L.,** U.S. Army Air Forces.
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T **Mayer, Frank S., Jr.,** Consolidated Aircraft Corp.
T **Mayer, Norman J.,** Goodyear Aircraft Corp.
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F **Mayo, Major Robert H.,** England.
M **Mayo, William B.,** Consulting Engineer.
T **Mazzari, Hugo Leopold,** Republic Aviation Corp.
I **McArthur, Warren,** Warren McArthur Corp.
F **McAvoy, William H.,** Ames Aero. Lab., N.A.C.A.
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T **McCall, Lt. E. L.,** U.S. Army.
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T **McCarthy, Ens. John R.,** U.S. Navy.
M **McCarty, Lewis C., Jr.,** Hindustan Aircraft Ltd., India.
T **McClain, Thomas H.,** Lockheed Aircraft Corp.
M **McClarren, Ralph H.,** The Franklin Institute of Philadelphia.
I **McClellan, Stephen A.,** Ranger Aircraft Engines Div., Fairchild Engine & Airplane Corp.
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M **McCoy, Col. Howard M.,** U.S. Army Air Forces.
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T **McCurdy, John D.,** Lockheed Aircraft Corp.
T **McDonald, J. Wallace,** Edward G. Budd Mfg. Co.
AF **McDonnell, James A.,** War Dept.
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T **McDonough, Charles F.,** McDonough Aircraft Corp.
T **McDougal, Allan R. B.,** Boeing Aircraft Co.
T **McElroy, John E.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **McFadden, William C.,** Pan American-Grace Airways, Inc., Peru.
M **McFadgen, Henry M.,** Jacobs Aircraft Engine Co.
M **McFarland, Dr. Ross A.,** Harvard Univ.
M **McFarlane, Robert M.,** The Glenn L. Martin Co.
T **McGinnis, William L.,** Ford Motor Co. of Canada, Ltd., Canada.
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T **McIver, Robert M.,** Cal-Aero. Acad.
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T **McLane, Philip W.,** Lockheed Aircraft Corp.
T **McLarren, Robert,** *Model Airplane News* Magazine.
T **McLarty, Jack L.,** Fleet Aircraft, Ltd., Canada.
M **McLaughlin, George F.,** Jordanoff Aviation Co.
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T **McRae, F. W., Jr.,** Boeing Aircraft Co.
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HM **Meigs, Merrill C.,** W.P.B.
T **Meins, Wallace W.,** Lockheed Aircraft Corp.
T **Meirs, John,** Grumman Aircraft Eng. Corp.
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T **Melker, Irving D.,** G & A Aircraft, Inc.
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AF **Mercier, Pierre E.,** General Aircraft Equipment, Inc.
AF **Meredith, Lt. Col. Russell L.,** U.S. Army Air Forces.
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AF **Mesinger, Frederick W.,** Norma-Hoffmann Bearings Corp.
T **Messinger, Bernard L.,** Lockheed Aircraft Corp.
AF **Metcalf, Prof. Arthur G. B.,** North American Research Corp.
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T **Middleton, James A.,** Lockheed Aircraft Corp.
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T **Miller, Edwin F.,** Socony-Vacuum Oil Co.
AF **Miller, Elton W.,** Langley Mem. Aero. Lab., N.A.C.A.
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T **Miller, Kenneth R.,** Bell Aircraft Corp.
M **Miller, Louis C.,** Brewster Aeronautical Corp.
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AF **Miller, William H.,** Navy Dept.
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T **Miner, Lindsey,** Lockheed Aircraft Corp.
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M **Mines, Chester E.,** Jacobs Aircraft Engine Co.
M **Mingos, Howard L.,** Aeronautical Chamber of Commerce of America.
M **Minser, Edward J.,** Transcontinental & Western Air, Inc.
F **Minshall, Robert J.,** Pump Eng. & Service Corp.
M **Mintz, Bernard,** Airplane Div., Curtiss-Wright Corp.
T **Mitchell, A. Edgar,** G & A Aircraft, Inc.
T **Mitchell, Bruce,** Consolidated Aircraft Corp.
AF **Mitchell, Charles L.,** U.S. Weather Bureau.
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T **Mock, Elliot V.,** Boeing Aircraft Co.
AF **Mock, Frank C.,** Bendix Products Div., Bendix Aviation Corp.
AF **Mock, Richard M.,** Lear Avia, Inc.
M **Mock, Wesley C., Jr.,** National Bureau of Standards.
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AF **Moffett, R. J.,** de Havilland Aircraft of Canada, Ltd., Canada.
I **Mohler, Capt. Orville E.,** U.S. Army Air Forces.
AF **Mohyla-Mokrzycki, Gustaw A.,** National Steel Car Corp. Ltd., Canada.
AF **Moles, Howard R.,** Airplane Div., Curtiss-Wright Corp.
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T **Monaco, A. P.,** Andover-Kent Aviation Corp.
AF **Moness, Elias,** Northrop Aircraft, Inc.
M **Montgomery, Lt. Wiley P.,** U.S. Navy.
T **Montieth, Oscar V.,** Allison Div., General Motors Corp.
T **Montoney, Richard L.,** Lockheed Aircraft Corp.
AF **Moodie, T. Edward,** Aviation Engineering, Inc.
M **Moon, Harold P.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Mooney, Al W.,** Culver Aircraft Corp.
T **Moore, Major C. K.,** U.S. Army Air Forces.
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T **Moore, Morton E.,** Douglas Aircraft Co., Inc.
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T **Moore, Wesley D.,** Douglas Aircraft Co., Inc.
T **Moore, William H.,** Ranger Aircraft Engines Div., Fairchild Engine & Airplane Co.
M **Moore-Brabazon, Lt. Col. John T. C.,** Ministry of Aircraft Production, England.
T **Morelli, J. F.,** Noorduyn Aviation Ltd., Canada.
I **Morgan, Thomas A.,** The Sperry Corp.
T **Moricca, Arthur F.,** The Texas Co.
T **Morrill, Carle C.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Morris, Charles W.,** General Electric Co.
M **Morris, Edward W.,** Aeroproducts Div., General Motors Corp.
T **Morris, H. A.,** Airplane Div., Curtiss-Wright Corp.
T **Morris, John K.,** Pacific Gear & Tool Works, Inc.
T **Morrison, Robert C.,** North American Aviation, Inc.
T **Mortlock, Walter E.,** Boeing Aircraft Co.
I **Morton, Charles I.,** Curtiss-Wright Corp.
T **Morton, Earl E.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Morvay, Anton A.,** Mills Novelty Co.
AF **Mosebach, Walter G. E.,** Goodyear Aircraft Corp.
T **Mosehauer, Edward,** Hamilton Standard Propellers Div., United Aircraft Corp.
I **Moseley, C. C.,** Aircraft Industries Corp.
AF **Moseley, David L.,** Douglas Aircraft Co., Inc.
T **Moses, Raymond E.,** Airplane Div., Curtiss-Wright Corp.
M **Moss, Virgil D.,** Lockheed Aircraft Corp.
T **Moy, Stanley,** Pan American Airways System.
T **Moyers, Capt. Frank N.,** U.S. Army Air Forces.
T **Mucha, Stephen,** Platt-LePage Aircraft Corp.
T **Mueller, Hans S.,** Airplane Div., Curtiss-Wright Corp.
T **Mueller, Robert K.,** Lord Mfg. Co.
T **Mueller, William A.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Mulholland, Frank J.,** Republic Aviation Corp.
M **Mulligan, Lt. Col. Denis,** U.S. Army Air Forces.
AF **Mullinnix, Capt. Henry M.,** U.S. Navy.
M **Mullowney, Penn E.,** The Glenn L. Martin Co.
AF **Muniz, Lt. Col. Antonio G.,** Brazilian Air Force, Brazil.
T **Munro, Robert B.,** Grumman Aircraft Eng. Corp.

T **Munroe, George E.,** Chamberlin Aircraft Corp.
I **Munsey, Herbert H.,** Bell Aircraft Corp.
T **Murphy, E. William,** C.A.A.
T **Murray, Lt. James L.,** U.S. Army Air Forces.
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T **Murrow, Richard B.,** Douglas Aircraft Co., Inc.
T **Muzzey, Clifford L.,** Aeroproducts Div., General Motors Corp.
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T **Myers, Richard H.,** Stewart-Rogers, Inc.
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T **Myron, George W.,** Acad. of Aeronautics.

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F **Nayler, J. L.,** Aeronautical Research Committee, England.
M **Nazir, P. P.,** Canada.
M **Nebesar, Dr. Robert J.,** Bristol Aircraft Div., Universal Moulded Products Corp.
T **Neeley, Glen E.,** War Dept.
T **Neff, Charles W.,** Emerson Electric Mfg. Co.
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T **Neighbours, Ens. James W.,** U.S. Navy.
T **Neihouse, Abe D.,** War Dept.
T **Nelson, Lt. Conrad N.,** War Dept.
M **Nelson, Donald E.,** Northrop Aircraft, Inc.
T **Nelson, John J.,** Boeing Aircraft Co.
T **Nelson, Vernon W.,** Douglas Aircraft Co., Inc.
AF **Nelson, Prof. Wilbur C.,** Iowa State College.
T **Nesbitt, L. M.,** Dept. of Transport, Canada.
T **Nesbitt, Marshall,** Douglas Aircraft Co., Inc.
M **Neville, Leslie E.,** *Aviation* Magazine.
T **Newberger, Eli S.,** Howard Aircraft Corp.
T **Newbold, George,** *Aviation* Magazine.
T **Newby, Clinton T.,** Navy Dept.
T **Newell, Bergen F.**
F **Newell, Prof. Joseph S.,** Mass. Inst. of Tech.
T **Newman, C. L.,** United Air Lines Transport Corp.
T **Newman, Clyde A.,** Lockheed Aircraft Corp.
T **Newmark, M. F., Jr.,** Consolidated Aircraft Corp.
M **Newton, Gaylord W.,** Boeing Aircraft Co.
T **Nichols, H. A., Jr.,** Douglas Aircraft Co., Inc.
T **Nickle, F. R.,** Ames Aero. Lab., N.A.C.A.
M **Nicoll, Reginald E.,** Handley Page Ltd., England.
M **Niedelman, Samuel,** Aviation Equipment & Export, Inc.
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AF **Nikolsky, Prof. Alexander,** Princeton Univ.
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AF **Noorduyn, R. B. C.,** Noorduyn Aviation Ltd., Canada.
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T **Normann, Erik,** Cox & Stevens Aircraft Corp.
T **Norris, Alexander R.,** Republic Aviation Corp.
T **Norris, Eugene W.,** Aeronautical Chamber of Commerce of America, Inc.
T **Norris, V. J.,** Airplane Div., Curtiss-Wright Corp.
T **North, Donald C.,** The Glenn L. Martin Co.
AF **North, J. D.,** Boulton Paul Aircraft Ltd., England.
T **North, Vincent W.,** Boeing Aircraft Co.
F **Northrop, John K.,** Northrop Aircraft, Inc.
T **Northrup, John L.,** Goodyear Aircraft Corp.
T **Nova, Robert A.,** Sperry Gyroscope Co., Inc.
T **Nowlan, F. S., Jr.,** R.C.A.F., Canada.
M **Noxon, P. A.,** Pioneer Instrument Div., Bendix Aviation Corp.
F **Nutt, Arthur,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Nye, Willis L.,** Vega Aircraft Corp.
T **Nylin, Nels E.,** Timm Aircraft Corp.
T **Nystrom, H. C.,** Lockheed Aircraft Corp.

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I **Oertel, Robb C.,** Standard Oil Co. of N.J.
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T **Olsen, Lt. Comdr. Carl Baker,** U.S. Coast Guard.
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AF **Olshevsky, D. E.,** Helicopter Corp. of America.
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T **O'Neal, W. B.,** The Glenn L. Martin Co.
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AF **Ostrander, Comdr. J. E., Jr.,** U.S. Navy.
T **Ostrom, Max T.,** Lockheed Aircraft Corp.
F **Oswald, W. Bailey,** Douglas Aircraft Co., Inc.
T **Otis, Dr. Arthur S.,** World Book Co.
T **O'Toole, Murray J.,** Langley Mem. Aero. Lab., N.A.C.A.
AF **Otto, Bowman R.,** Breeze Corporations, Inc.
M **Outman, H. V.,** The Glenn L. Martin Co.
AF **Ovens, W. G.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
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T **Pagon, Garrett D.,** Edward G. Budd Mfg. Co.
AF **Pagon, W. Watters,** Consulting Engineer.
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I **Palmer, John R.,** Chicago Pneumatic Tool Co.
AF **Palmer, Richard W.,** Vultee Aircraft, Inc.
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I **Parker, J. Brooks B.,** Parker & Co.
I **Parker, J. Scott, Jr.,** C.A.A.
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AF **Percival, E. W.,** Percival Aircraft Ltd., England.
T **Perkins, A. Wallie,** American Airlines, Inc.
AF **Perkins, Kendall,** McDonnell Aircraft Corp.
AF **Perrin, Harold E.,** The Royal Aero Club, England.
T **Perry, Albert J., Jr.,** The Glenn L. Martin Co.
M **Perry, J. P.,** G & A Aircraft, Inc.
T **Perry, Lt. Millard F.,** U.S. Army Air Forces.
M **Perry, Thomas D.,** Resinous Products & Chemical Co.
T **Pesek, Wilbert G.,** Consolidated Aircraft Corp.
AF **Peterman, Lt. Col. E. A.,** U.S. Army Air Forces.
T **Peters, Elwyn H.,** Airplane Div., Curtiss-Wright Corp.
M **Peters, Eric C.,** The Glenn L. Martin Co.
M **Peters, William H.,** Airplane Div., Curtiss-Wright Corp.
M **Peterson, C. Gilbert,** Railway Express Agency, Inc.
T **Peterson, Lt. James G.,** U.S. Army Air Forces.
T **Peterson, Lyndon L.**
T **Petrasek, William A.,** American Airlines, Inc.
T **Petrey, Roger A.,** General Motors Corp.
AF **Petroff, Alexander N.,** Airplane Div., Curtiss-Wright Corp.
T **Petry, H. Wayne,** Brewster Aeronautical Corp.
M **Petterssen, Dr. Sverre,** Mass. Inst. of Tech.
T **Pettingall, Charles E., Jr.,** Douglas Aircraft Co., Inc.
T **Pfaff, G. C., Jr.,** The Glenn L. Martin Co.
T **Pfeiffer, Shelly B.,** Douglas Aircraft Co., Inc.
T **Philipp, Paul A.,** Lockheed Aircraft Corp.
T **Phillips, Frederick C.,** The Glenn L. Martin Co.
I **Phillips, James A.,** Phillips Aviation Co.
M **Phillips, Michael J.,** Jack & Heintz, Inc.
T **Phillips, William H.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Pianowski, L. J.,** Udylite Corp.
T **Piasecki, F. N.,** Edward G. Budd Mfg. Co.
T **Piatt, Perry E.,** Virginia Polytech. Inst.
AF **Piccard, Jean F.,** Univ. of Minnesota.
T **Pichenot, L. F.,** Nigucol Aircraft.
T **Picken, Harry B.,** White Canadian Aircraft, Canada.
T **Pickett, Robert D.,** Lockheed Aircraft Corp.
T **Pierce, Ernest W.,** Douglas Aircraft Co., Inc.
F **Pierson, R. K.,** Vickers Armstrong Ltd., England.
M **Pigman, George L.,** C.A.A.
AF **Pihl, Lt. Comdr. P. E.,** U.S. Navy.
M **Pinkel, Benjamin,** Langley Mem. Aero. Lab., N.A.C.A.
AF **Pinkerton, Prof. Robert M.,** A. & M. College of Texas.
T **Pinto, Albert A.,** U.S. Navy.
M **Piper, Paul A.,** The Glenn L. Martin Co.
T **Pipitone, S. Joseph,** The Glenn L. Martin Co.
F **Pippard, Prof. A. J. S.,** Univ. of London (Imperial College), England.
I **Pitcairn, Harold F.,** Autogiro Co. of America; G & A Aircraft, Inc.
T **Pitman, W. Andrew,** Bristol Aircraft Div., Universal Moulded Products, Inc.
T **Pitt, William G.,** Lockheed Aircraft Corp.
T **Pitts, Prof. Robert G.,** Alabama Polytech. Inst.
M **Pixton, Comdr. J. E.,** U.S. Navy.
M **Planiol, André P. E.,** Stratos Corp.
T **Platt, F. N.,** Fleetwings, Inc.
AF **Platt, H. H.,** Platt-LePage Aircraft Co.
T **Platz, Donald E.,** Snead & Co.
M **Plesset, Dr. M. S.,** Douglas Aircraft Co., Inc.
T **Plommer, William D.,** Mackenzie Air Service Ltd., Canada.
T **Plummer, R. S.,** Batwing Corp.
T **Podolsky, Arnold C.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
HM **Pogue, Hon. L. Welch,** C.A.B.
T **Pollock, Robert T. Jr.,** Consolidated Aircraft Corp.
T **Polowniak, Emil A.,** Emerson Electric Mfg. Co.
T **Pomerantz, Herbert B.,** Douglas Aircraft Co., Inc.
T **Poor, Ens. Charles L., III,** U.S. Navy.
T **Poorman, George E.,** Airplane Div., Curtiss-Wright Corp.
T **Pope, Prof. Alan Y.,** Georgia School of Tech.
T **Pope, Douglas H.,** North American Aviation, Inc.
T **Pope, George H.,** Northrop Aircraft, Inc.
T **Pope, Robert Alden,** Republic Aviation Corp.
M **Poppen, Capt. J. R.** (M.C.), U.S. Navy.
T **Porowski, Casimer,** The Glenn L. Martin Co.

M **Porter, L. Morgan,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Poskus, Ens. Alexander S.,** U.S. Navy.
M **Post, George B.,** Edo Aircraft Corp.
T **Post, John E. H.,** Republic Aviation Corp.
T **Posten, Walter C.,** Pan American Airways System.
I **Potter, Charles A.,** The Texas Co.
T **Potters, Stephen,** Republic Aviation Corp.
T **Pottetti, Mario A.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Potts, Charles H.**
M **Powell, Lt. Mortimer,** U.S. Army Air Forces.
T **Powell, Walter B.,** Calif. Inst. of Tech.
T **Power, James T.,** Lockheed Aircraft Corp.
T **Powers, Joseph W.,** Douglas Aircraft Co., Inc.
T **Powers, Paul J., Jr.,** Scintilla Magneto Div., Bendix Aviation Corp.
AF **Prager, Prof. W.,** Brown Univ.
T **Prahin, Edward J.,** Lockheed Aircraft Corp.
T **Pratt, Edward A.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
AF **Pratt, Haraden,** Mackay Radio & Telegraph Co.; International Telephone Development Co.
M **Pratt, Wallace E.,** Standard Oil Co. of N.J.
T **Prentice, B. R.,** General Electric Co.
T **Preston, A. Dale,** Emerson Electric Mfg. Co.
T **Preston, Merritt,** Aero. Engine Research Lab., N.A.C.A.
AF **Prewitt, R. H.,** Kellett Autogiro Corp.
T **Price, R. Allen,** Platt-LePage Aircraft Co.
F **Priester, A. A.,** Pan American Airways System.
T **Priff, George,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Prince, David C.,** General Electric Co.
T **Pritchard, George W.,** The Glenn L. Martin Co.
AF **Pritchard, J. Laurence,** Royal Aeronautical Society, England.
T **Probst, Joseph,** Grumman Aircraft Eng. Corp.
T **Propper, Edouard M.,** Consolidated Aircraft Corp.
T **Prusas, V. J.,** Fisher Body Corp.
T **Puck, Lt. Richard F.,** U.S. Army Air Forces.
T **Puckett, Allen E.,** Calif. Inst. of Tech.
T **Pugh, Ralph M.,** Republic Aviation Corp.
I **Purdy, C. V. S.,** The Felters Co., Inc.
T **Purser, Paul E.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Pusin, Herman,** The Glenn L. Martin Co.
T **Putt, Col. Donald L.,** U.S. Army Air Forces.
T **Putt, Gladyn H.,** Douglas Aircraft Co., Inc.
HF **Pye, D. R.,** Air Ministry, England.
T **Pyle, Raymond W.,** Ryan Aeronautical Co.
AF **Pyne, Frederick C.,** Aluminum Co. of America.

T **Quady, John C.,** Emerson Electric Mfg. Co.
T **Quate, Boyd E.,** U.S. Army Air Forces.
T **Quermann, J. K.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.

I **Raabe, Arthur E.,** Pioneer Instrument Div., Bendix Aviation Corp.
T **Raetz, Gibbs S.,** Lockheed Aircraft Corp.
T **Rafalsky, Lloyd A.,** U.S. Government.
T **Rafferty, Christopher A.,** Pioneer Instrument Div., Bendix Aviation Corp.
T **Rager, William H.,** Ryan Aeronautical Co.
M **Raiche, Louis G.,** Airplane Div., Curtiss-Wright Corp.
M **Ramberg, Walter,** National Bureau of Standards.
AF **Ramsden, Earl I.,** Grumman Aircraft Eng. Corp.
T **Randall, Fred W., Jr.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
I **Randall, I. S.,** Transcontinental & Western Air, Inc.
M **Randolph, Donald W.,** Apex Electrical Mfg. Co.
T **Randolph, John L.,** North Carolina State College.
T **Ranney, Daniel R.,** The Glenn L. Martin Co.
T **Ranson, Charles W.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Rappleyea, Frederick A.,** Dow Chemical Co.
T **Raser, W. H.,** Propeller Div., Curtiss-Wright Corp.
T **Rasmussen, Borge A.,** Douglas Aircraft Co., Inc.
T **Rasumoff, Abner.**
AF **Rauscher, Prof. Manfred,** Mass. Inst. of Tech.
T **Rautenstrauch, Prof. Robert,** North Carolina State College.
T **Raven, Ens. Julius A.,** U.S. Navy.
F **Raymond, Arthur E.,** Douglas Aircraft Co., Inc.
M **Raymond, Leonard,** Tide Water Associated Oil Co.
T **Razak, Prof. C. Kenneth,** Univ. of Kansas.
T **Rechlin, Floyd,** Consolidated Aircraft Corp.
AF **Reddig, James C.,** Kenyon Instrument Co.
AF **Redding, James D.,** Society of Automotive Engineers.
I **Redhed, William S.,** Impact Register Co.
T **Redwine, Dan A.,** Consolidated Aircraft Corp.
M **Reed, Albert C.,** Boeing Aircraft Co.
T **Reed, Herbert W.,** The Aeronautical Univ., Inc.
T **Reed, Norman W.,** Vultee Aircraft, Inc.
T **Reeder, John P.,** Langley Mem. Aero. Lab., N.A.C.A.
I **Reeks, William A.,** Curtiss-Wright Corp.
M **Reff, E. Robert,** Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.
AF **Reichel, W. A.,** Pioneer Instrument Div., Bendix Aviation Corp.
F **Reichelderfer, Dr. Francis W.,** U.S. Weather Bureau.
M **Reid, Charles T.,** Douglas Aircraft Co., Inc.
F **Reid, Prof. Elliott G.,** Stanford Univ.
F **Reid, Henry J. E.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Reisner, J. Henry,** Aircraft Accessories Corp.
I **Reisner, Lewis E.,** Tennessee Aircraft Inst., Inc.
AF **Reissner, Prof. Hans,** Illinois Inst. of Tech.
F **Relf, Ernest F.,** National Physical Laboratory, England.
M **Rendel, T. B.,** British Air Commission.
AF **Renison, William H., Jr.,** Consolidated Aircraft Corp.
I **Rentschler, Frederick B.,** United Aircraft Corp.
M **Resos, Eugene P.,** Vultee Aircraft, Inc.
T **Rethorst, Scott C.,** Goodyear Tire & Rubber Co.
M **Rettenmeyer, Francis X.,** RCA Mfg. Co., Inc.
M **Rettenmeyer, Ray D.,** *Communications* Magazine.
T **Reynolds, Blake,** Lawrance Eng. & Research Corp.
T **Reynolds, Eugene J.,** Boeing Aircraft Co.
T **Reynolds, Francis D.,** Boeing Aircraft Co.
M **Rhines, Thomas B.,** Hamilton Standard Propellers Div., United Aircraft Corp.
T **Rhoads, W. R.,** Vega Aircraft Corp.
M **Rhode, Richard V.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Rialson, Capt. Donald E.,** U.S. Army Air Forces.
M **Ribner, Dr. H. S.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Rice, Lt. Charles F.,** U.S. Army Air Forces.
M **Rice, Janvier M.,** Airplane Div., Curtiss-Wright Corp.
T **Rich, Jack V.,** Douglas Aircraft Co., Inc.
T **Richards, Cyril E.,** Consolidated Aircraft Corp.
AF **Richardson, Avery G.,** Boonton Radio Corp.
T **Richardson, Charles L.,** Boston Univ.
T **Richardson, David A.,** Aeroproducts Div., General Motors Corp.
F **Richardson, Capt. Holden C.,** U.S. Navy (Ret.).
M **Richter, E. O.,** Lockheed Aircraft Corp.
M **Richter, Paul E.,** Transcontinental & Western Air, Inc.
M **Ricketts, Donald H.,** American Airlines, Inc.

M **Rifenbergh, C. Morgan,** Federal Telephone & Radio Corp.
T **Rightmire, Brandon G.,** Mass. Inst. of Tech.
AF **Riley, Robert S.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Rinek, John A.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Ringham, Rodger F.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Rios, Robert,** North American Aviation, Inc.
T **Rioux, Richard N.,** Emerson Electric Mfg. Co.
M **Ripley, Charles B.,** Aero Insurance Underwriters.
T **Ritchie, Lt. Perry J.,** U.S. Army Air Forces.
T **Ritter, Arthur,** Aircraft Research Corp.
T **Rittweger, John D.,** Vega Aircraft Corp.
T **Roach, Jere H.,** Bury Compressor Co.
T **Roark, Lt. Robert L.,** U.S. Army Air Forces.
T **Robb, John Albert,** Navy Dept.
M **Roberts, Clifford E.,** The Glenn L. Martin Co.
AF **Roberts, Francis A.,** Air Ministry, England.
T **Roberts, F. Morley,** General Electric Co.
T **Roberts, Phillip H.,** Lockheed Aircraft Corp.
T **Roberts, Lt. Wilbur E.,** U.S. Navy.
AF **Robertson, Burton J.,** Univ. of Minnesota.
T **Robertson, Donald R.,** Sperry Gyroscope Co., Inc.
T **Robertson, Leo P.,** National Steel Car Co., Canada.
T **Robinson, Harold L.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Robinson, James D., Jr.,** The Glenn L. Martin Co.
T **Robinson, Joseph I.,** Bell Aircraft Corp.
AF **Robinson, Russell G.,** Ames Aero. Lab., N.A.C.A.
M **Robinson, S. T.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Robinson, Theodore D.,** Grumman Aircraft Eng. Corp.
T **Robischon, Ernest W.,** Calif. Inst. of Tech.
T **Rocco, Angelo M.,** Navy Dept.
I **Rockefeller, Lt. Laurance S.,** U.S. Army Air Forces.
AF **Rockefeller, William C.,** Vultee Aircraft, Inc.
M **Roever, Frederick H.,** Parks Air College.
T **Roffelsen, Harry J.,** Casey Jones School of Aeronautics.
M **Rogallo, Francis M.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Rogers, John,** Rising Sun School of Aeronautics.
M **Rogowski, A. R.,** Mass. Inst. of Tech.
M **Rohman, Eugene,** Vega Aircraft Corp.
AF **Root, Leonard E.,** Douglas Aircraft Co., Inc.
T **Rosan, Howard J.,** Brewster Aeronautical Corp.
T **Rosen, Dexter,** Vega Aircraft Corp.
T **Rosen, George,** Hamilton Standard Propellers Div., United Aircraft Corp.
M **Rosen, Joseph,** New York Univ.
T **Rosenbaum, Mortimer,** Consolidated Aircraft Corp.
T **Rosenberg, Joseph, Jr.,** U.S. Army Air Forces.
F **Rosendahl, Capt. Charles E.,** U.S. Navy.
T **Rosenkrantz, Calman,** Republic Aviation Corp.
T **Ross, James J.,** Indiana Tech. College.
T **Ross, Robert,** Guggenheim Airship Inst.
T **Ross, Roland A.,** Timm Aircraft Corp.
F **Rossby, Prof. C.-G. A.,** Univ. of Chicago.
T **Rossman, Carl A.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Rossmann, Peter F.,** Airplane Div., Curtiss-Wright Corp.
T **Rotelli, Ranieri L.,** Boeing Aircraft Co.
T **Roth, John F.,** Vultee Aircraft, Inc.
AF **Rothrock, Addison M.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Rottmayer, Earl,** Dow Chemical Co.
T **Rounds, George L.,** Doak Aircraft Co.; Briegleb Sailplane Corp.
T **Rousseau, William A.,** Airplane Div., Curtiss-Wright Corp.
F **Rowledge, Arthur J.,** Rolls-Royce Ltd., England.
T **Rozsa, William P.,** American Airlines, Inc.
T **Rubin, Arnold E.,** Lockheed Aircraft Corp.
T **Rubin, Norman N.,** C.A.A.
AF **Ruffner, Prof. Benjamin F., Jr.,** Oregon State College.
M **Rummel, Robert W.,** Rearwin Aircraft & Engines, Inc.
T **Rumph, Lewis B., Jr.,** Airplane Div., Curtiss-Wright Corp.
T **Rumsey, Charles B.,** Georgia School of Tech.
M **Runstad, Harold J.,** Boeing Aircraft Co.
T **Russell, Edgar Farr,** District of Columbia Public Schools.
I **Russell, Frank F.,** National Aviation Corp.
I **Russell, Frank H.,** Manufacturers Aircraft Association.
T **Russell, Howard,** Vultee Aircraft, Inc.
M **Russell, Dr. Howard W.,** Battelle Mem. Inst.
AF **Russell, Lt. Comdr. James S.,** U.S. Navy.
T **Russell, John H.,** Boeing Aircraft Co.
I **Russell, J. J.,** Canadian Car & Foundry Co., Canada.
T **Ruszaj, Norbert F.,** Univ. of Minnesota.
T **Rutkoskie, Gerald V.,** Douglas Aircraft Co., Inc.
T **Rychetsky, Rudolf A.,** The Glenn L. Martin Co.
T **Ryder, Edward I.,** C.A.A.
AF **Rydlun, Major Edwyn G.,** U.S. Army Air Forces.
T **Sager, Lt. J. Parke,** U.S. Navy.
T **Sailer, Ernest R.,** Lockheed Aircraft Corp.
T **Saks, Robert,** Consolidated Aircraft Corp.
M **Salter, Tom,** Cessna Aircraft Co.
I **Saltus, R. S.,** Markeim-Chalmers-Ludington, Inc.
T **Saltzman, E. Clifford,** War Dept.
T **Samson, David P., Jr.,** The Glenn L. Martin Co.
AF **Sanborn, John A.,** Manufacturers Aircraft Association.
T **Sandel, W. D., Jr.,** Bendix Aviation Corp.
T **Sanders, Lt. Comdr. Robert,** Navy Dept.
T **Sandgren, Frank B.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Sandorff, Paul E.,** Lockheed Aircraft Corp.
T **Sandowski, Wladyslaw,** Conmar Products Corp.
M **Sandstrom, Roy J.,** Bell Aircraft Corp.
M **Sanford, Carl N.,** Boeing Aircraft Co.
T **Sanford, Lt. Charles A.,** U.S. Army Air Forces.
M **Sangster, William A.,** Vega Airplane Corp.
T **Santilli, Alcide,** Feiber Instrument Co.
T **Sargent, E. R.**
M **Sargent, H. H., Jr.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
M **Sartore, S. R.,** Airplane Div., Curtiss-Wright Corp.
T **Saslowsky, Morris,** Kollsman Instrument Div., Square D Co.
M **Satin, Alexander,** Ford Motor Co.
AF **Sauerwein, Robert T.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
T **Saunders, Herbert,** Consolidated Aircraft Corp.
T **Saut, Jules F.,** Dow Chemical Co.
T **Savage, Charles A.,** Consolidated Aircraft Corp.
M **Saville, Thorndike,** New York Univ.
T **Sawdey, Marshall D.,** Bell Aircraft Corp.
T **Sawyer, James G.,** Airplane Div., Curtiss-Wright Corp.
I **Sawyer, Marion Bell,** Sawyer Electrical Mfg. Co.
I **Sawyer, M. B., Jr.,** Sawyer Electrical Mfg. Co.
T **Sawyer, Richard H.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Scales, H. S.,** Pan American Airways System.
T **Scarbrough, J. W., Jr.,** Douglas Aircraft Co., Inc.
M **Schaal, Ellsworth A.,** Boeing Aircraft Co.
AF **Schaefer, Everett B.,** The Glenn L. Martin Co.
T **Schaefer, William H.,** Consolidated Aircraft Corp.
T **Schaeffer, David,** Continental Motors Corp.
M **Schairer, George S.,** Boeing Aircraft Co.
T **Schairer, Robert S.,** Douglas Aircraft Co., Inc.

T **Schell, Charles J., Jr.,** Casey Jones School of Aeronautics.
T **Scherer, John Albert,** McDonnell Aircraft Corp.
T **Scherrer, Richard,** Ames Aero. Lab., N.A.C.A.
T **Schetzer, J. D.,** Vultee Aircraft, Inc.
AF **Schildhauer, Comdr. C. H.,** U.S. Navy.
T **Schlegel, Iven L.,** Noorduyn Aviation Ltd., Canada.
T **Schlesier, Raymond,** Ranger Aircraft Engines Div., Fairchild Engine & Airplane Corp.
T **Schliestett, Lt. Geo. V.,** U.S. Navy.
M **Schlotzhauer, Lt. Col. H. A., Jr.,** U.S. Army Air Forces.
T **Schmidt, Carl F.,** Lockheed Aircraft Corp.
T **Schmidt, E. F.,** Airplane Div., Curtiss-Wright Corp.
T **Schnaubelt, Frank J.,** Consolidated Aircraft Corp.
T **Schnaubelt, N. C.,** Consolidated Aircraft Corp.
I **Schneck, Lt. P. H.,** U.S. Army Air Forces.
T **Schneider, Irving,** Snead & Co.
T **Schneyer, Raymond I.,** Navy Dept.
AF **Schnitzer, Benjamin J.,** Goodyear Aircraft Corp.
T **Schoch, Edwin F.,** U.S. Army.
T **Schoech, Lt. Comdr. W. A.,** U.S. Navy.
T **Schoen, Lt. Wm. C.,** U.S. Army Air Forces.
T **Schoenfeldt, M. R.,** North American Aviation, Inc.
M **Schofield, E. B.,** Sperry Gyroscope Co., Inc.
I **Scholle, Howard A.,** Aeronautical Archives.
T **Schoolfield, Wm. C.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Schoonmaker, Robert J.,** The Glenn L. Martin Co.
M **Schory, Carl F.,** Hamilton Standard Propellers Div., United Aircraft Corp.
T **Schram, Ens. Richard A.,** U.S. Navy.
T **Schreiber, Ralph B.,** North American Aviation, Inc.
M **Schroeder, R. W.,** United Air Lines Transport Corp.
T **Schroeppel, Charles, Jr.,** Airplane Div., Curtiss-Wright Corp.
T **Schroeter, Lt. Otto E.,** U.S. Army.
AF **Schubauer, Dr. G. B.,** National Bureau of Standards.
T **Schubniner, Sanford E.,** Holderman Air Service, Inc.
T **Schuler, John E.**
T **Schulz, August,** The BG Corp.
T **Schunter, Hollis H.,** Pan American Airways System.
T **Schuster, Oscar,** Lockheed Aircraft Corp.
M **Schwartz, A. M.,** Northrop Aircraft, Inc.
T **Schwartzapfel, Wilbert,** Brewster Aeronautical Corp.
T **Schwendener, Karl D.,** Librascope Development Co.
AF **Schwendler, Wm. T.,** Grumman Aircraft Eng. Corp.
M **Schwenn, Kurt R.,** Pioneer Instrument Div., Bendix Aviation Corp.
T **Schwien, Nevin,** L. N. Schwien Eng. Co.
T **Scolaro, Dominick R.,** Brewster Aeronautical Corp.
M **Scoles, Lt. Comdr. A. B.,** U.S. Navy.
T **Scott, Benjamin C., Jr.,** Airplane Div., Curtiss-Wright Corp.
M **Scott, C. W.,** Airplane Div., Curtiss-Wright Corp.
T **Scott, John F.,** Consolidated Aircraft Corp.
AF **Scott, Dr. Merit,** The Pennsylvania State College.
AF **Scudder, Nathan F.,** C.A.A.
T **Scull, Guy H.,** Mid-Continent Airlines.
T **Seager, Donald B.,** Lockheed Aircraft Corp.
T **Seamans, Robert C., Jr.,** Mass. Inst. of Tech.
M **Seamons, Joseph P.,** Vega Aircraft Corp.
M **Sears, J. F.,** Noorduyn Aviation Ltd., Canada.
M **Sears, William R.,** Northrop Aircraft, Inc.
AF **Sechler, Dr. E. E.,** Calif. Inst. of Tech.
T **Secord, Wm. P.,** North American Aviation, Inc.
T **Seldman, Oscar,** Langley Mem. Aero. Lab., N.A.C.A.
T **Seiferth, R. W.,** The Glenn L. Martin Co.
M **Seitz, Dr. Clifford P.,** College of the City of New York.
T **Self, J. Howard,** Interstate Aviation & Eng. Corp.
T **Seltzer, Leon Z.,** Virginia Polytech. Inst.
AF **Semion, W. A.,** H. J. Heinz Co.
M **Sempill, Lord William Francis Forbes-,** England.
T **Senior, John L., Jr.,** The Glenn L. Martin Co.
T **Sentker, Lt. C. L.,** U.S. Army.
T **Sepulveda Riveros, Lt. L. A.,** Chilean Air Force.
T **Serbin, Dr. Hyman,** Fairchild Aircraft Div., Fairchild Engine & Aviation Corp.
M **Serebreny, S. M.,** Pan American Airways System.
M **Serrallés, Juan K.,** Casey Jones School of Aeronautics.
T **Seulke, Donald K.,** Vega Aircraft Corp.
I **Sewall, Sumner,** United Air Lines Transport Corp.
T **Seyfarth, Robert M.,** Lockheed Aircraft Corp.
AF **Seymour, Lester D.,** The Pitcairn Co.
AF **Shangraw, Clayton C.,** Eclipse Aviation Div., Bendix Aviation Corp.
AF **Shanley, F. R.,** Lockheed Aircraft Corp.
M **Shapter, Nelson N.,** C.A.A.
T **Sharp, Charles W.,** The Glenn L. Martin Co.
M **Sharp, John W.,** Douglas Aircraft Co., Inc.
I **Sharples, L. P.,** The Sharples Corp.
T **Shattuck, Bernard F.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
AF **Shaw, Elgin L.,** Goodyear Aircraft Corp.
T **Shaw, Francis,** Electrol, Inc.
AF **Shaw, Sir (William) Napier,** Imperial College of Science & Technology, England.
T **Shaw, Samuel S.,** General Aircraft Corp.
M **Shaw, Wm. U.,** National Steel Car Corp. Ltd., Canada.
T **Shaw, Wilfred H.,** Hamilton Standard Propellers Div., United Aircraft Corp.
T **Shearston, David W.,** Fleetwings, Inc.
AF **Shebat, Herbert V.,** Safety Bureau, C.A.B.
T **Shedd, John V.,** Pan American Airways System.
T **Sheets, Jack H.,** Propeller Div., Curtiss-Wright Corp.
F **Shelmerdine, Lt. Col. Sir Francis,** Air Ministry, England.
M **Shelton, Thomas M.,** Aero Industries Tech. Inst.
M **Shepard, Irving A.,** McDonnell Aircraft Corp.
T **Shepard, William B.,** Waco Aircraft Co.
M **Shepley, Major Philip,** U.S. Army Air Forces.
AF **Sheridan, Dr. Laurence W.,** College of Mount St. Vincent.
T **Sherwin, Samuel B.,** Grumman Aircraft Eng. Corp.
T **Shick, Ralph H.,** Vultee Aircraft, Inc.
T **Shieber, Herbert,** Airplane Div., Curtiss-Wright Corp.
M **Shields, Bert A.,** Aviation Writer.
T **Shiley, Lt. Donald H.,** U.S. Navy.
AF **Shoemaker, Capt. James M.,** U.S. Navy.
AF **Shoemaker, James Maurice,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Shorey, H. S., Jr.,** Propeller Div., Curtiss-Wright Corp.
T **Short, M. L. L.,** American Airlines, Inc.; Engine Power Pump Co.
F **Short, Mac,** Vega Aircraft Corp.
T **Short, Robert Q.,** Lockheed Aircraft Corp.
T **Shorter, J. W.,** The Glenn L. Martin Co.
M **Shoults, D. R.,** General Electric Co.
T **Shuler, William T.,** Edward G. Budd Mfg. Co.
AF **Shumovsky, Stanislav A.,** Amtorg Trading Corp.
AF **Sibert, Major H. W.,** U.S. Army Air Forces.
M **Sibila, Alfred I.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
AF **Sigrist, Frederick,** Hawker Aircraft Ltd., England.
F **Sikorsky, Igor Alexis,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
F **Sikorsky, Igor I.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Silliman, John C.,** Pacific Railway Equipment Co.
T **Silos, Manuel, Jr.,** Paramount Eng. Co.
I **Silsbee, Capt. N. F.,** U.S. Army Air Forces.
T **Siltanen, John C.,** U.S. Army Air Forces.
AF **Silverstein, Abe,** Langley Mem. Aero. Lab., N.A.C.A.

T **Silverstein, Matthew,** Snead & Co.
M **Simms, Manuel S.,** Northrop Aircraft, Inc.
I **Simon, Lt. S. Thomas,** U.S. Navy.
T **Simonds, Colwert P.,** Consolidated Aircraft Corp.
M **Sims, Leland W.,** The Aeronautical Univ., Inc.
AF **Sims-White, Lt. H. W.,** R.A.F., England.
M **Sinclair, C. E.,** Institute of the Aeronautical Sciences.
M **Sinclair, Lt. Frank D.,** China Defense Supplies, Inc.
T **Sirc, Joseph H.,** Goodyear Aircraft Corp.
T **Skelton, Eric,** Scottish Aviation Ltd., Scotland.
M **Skinner, Lloyd H.,** Grumman Aircraft Eng. Corp.
T **Skoglund, Victor J.**
T **Skoog, James A.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Skoog, Richard B.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Slattery, John J.,** Pan American Airways System.
T **Slaughter, Lomis, Jr.,** Boeing Aircraft Co.
T **Slawson, Roy G. R.,** Lockheed Aircraft Corp.
T **Slifer, Robert L.,** Mid-Continent Airlines, Inc.
T **Small, Ramond E.,** General Electric Co.
T **Small, Ronald J.,** Brewster Aeronautical Corp.
T **Smart, Wm. Mitchell,** Nicholson File Co.
T **Smisko, Andy,** United Air Lines Transport Corp.
T **Smith, Alvin C.,** Airplane Div., Curtiss-Wright Corp.
M **Smith, Apollo M. O.,** Douglas Aircraft Co., Inc.
M **Smith, Chester Warren,** General Electric Co.
T **Smith, Clarence P.**
AF **Smith, Lt. Comdr. Clyde W.,** U.S. Navy.
I **Smith, Col. C. R.,** U.S. Army Air Forces.
M **Smith, Dean C.,** Airplane Div., Curtiss-Wright Corp.
M **Smith, Donald B.,** Northrop Aircraft, Inc.
T **Smith, George C.,** R.C.A.F., Canada.
T **Smith, George P.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Smith, George W., Jr.,** Bendix Aviation Corp.
M **Smith, Halwyn, R.,** Grand Rapids Store Equipment Co.
I **Smith, J. Hopkins,** Pan American Airways-Africa Ltd.
I **Smith, J. Story,** Jacobs Aircraft Engine Co.
T **Smith, James N.,** Vultee Aircraft, Inc.
T **Smith, James V.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Smith, Kenneth E.,** McDonnell Aircraft Corp.
T **Smith, Larz M.,** Waco Aircraft Co.
T **Smith, Lester W., Jr.,** Snead & Co.
T **Smith, Richard E.,** Boeing Aircraft Co.
AF **Smith, Prof. Richard H.,** Mass. Inst. of Tech.
I **Smith, Richard S.,** Rigid-Tex Corp.
T **Smith, Robert B.,** Douglas Aircraft Co., Inc.
T **Smith, Roderick N.,** Lockheed Aircraft Corp.
T **Smith, Ronald H.,** Mass. Inst. of Tech.
T **Smith, Roy,** Lockheed Aircraft Corp.
T **Smith, Roy V.,** Rensselaer Polytech. Inst.
AF **Smith, Wesley L.,** Virginia Rubatex Corp.
M **Smith, William M.,** Bell Aircraft Corp.
M **Smithline, Lawrence N.,** Langley Aviation Corp.
T **Snedeker, Monte H.,** C.A.A.
T **Snell, Wm. D.,** Propeller Div., Curtiss-Wright Corp.
T **Snodgrass, Reuben,** U.S. Navy.
T **Sobieralski, A. J.,** Boeing Aircraft Co.
M **Soellner, Rudolf.**
T **Soennichsen, Matthew E.,** Navy Dept.
T **Soike, Henry E.,** Pan American Airways System.
T **Sokol, Max,** H. J. Heinz Co.
T **Sokolsky, Oliver M.,** North American Aviation, Inc.
AF **Somers, Francis P.,** The Aviation Corp.
AF **Sontag, Harcourt,** Navy Dept.
I **Sopwith, T. O. M.,** Hawker Siddeley Aircraft Ltd., England.
T **Sorensen, Harold P.**
T **Sorenson, Lt. E. L.,** U.S. Army Air Forces.
T **Sorenson, Myrvel A.,** Diesel Engine Div., General Motors Corp.
T **Soult, Stanley S.,** U.S. Army Air Forces.
T **Souter, Robert K.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Southack, Tilden Ward,** The Aerotorque Co.
M **Southee, Earl R.,** C.A.A.
F **Southwell, Prof. R. V.,** Univ. of Oxford, England.
M **Sowle, Charles E.,** Lockheed Aircraft Corp.
AF **Spangler, Comdr. Selden B.,** U.S. Navy.
T **Spanski, Ray J.,** Detroit Outboard Products Corp.
M **Sparks, Brian Orville,** Bell Aircraft Corp.
M **Sparling, E. C.,** Sperry Gyroscope Co., Inc.
T **Spaulding, Edward,** Lockheed Aircraft Corp.
M **Spaulding, Ellis R.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Spaulding, M. B., Jr.,** The Glenn L. Martin Co.
AF **Spaulding, Dr. Roland H.,** New York Univ.
T **Speas, Robert D.,** American Airlines, Inc.
T **Speer, Edmund M., Jr.,** Pratt & Whitney Aircraft Div., United Aircraft Corp.
M **Speir, Capt. Godfrey B.,** U.S. Army.
T **Spektor, Sam S.,** Duramold Aircraft Corp. Div., Fairchild Engine & Airplane Corp.
I **Spencer, L. V.,** *Aero Digest* Magazine.
M **Spencer, Robert D.,** McDonnell Aircraft Corp.
M **Sperry, Edward G.,** Sperry Products, Inc.
F **Sperry, Elmer A., Jr.,** Sperry Products, Inc.
AF **Spey, Herbert J.,** Navy Dept.
T **Spiegel, Herman B.,** Duncan Tool Designing Co.
T **Spiegel, Joseph M.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Spielberg, Irvin,** U.S. Army Air Forces.
M **Spiess, Paul C.,** C.A.A.
AF **Spilhaus, Athelstan F.,** New York Univ.
AF **Spillinger, H. G.,** Lawrance Eng. & Research Corp.
T **Spofford, Edwin F.,** The Glenn L. Martin Co.
M **Springer, B. L.,** C.A.A.
M **Springfield, J. B.,** United Aircraft Corp.
T **Spryer, Edward N., Jr.,** Airplane Div., Curtiss-Wright Corp.
T **Squiers, John C.,** Briggs Mfg. Co.
AF **Stack, John,** Langley Mem. Aero. Lab., N.A.C.A.
AF **Stalb, A. Ralston,** Grumman Aircraft Eng. Corp.
AF **Stalker, Edward A.,** Dow Chemical Co.
T **Stamy, J. L.,** U.S. Army Air Forces.
AF **Stanley, Paul H.,** G & A Aircraft, Inc.
M **Stanley, Robert M.,** Bell Aircraft Corp.
T **Stanton, I. A., III.**
T **Stanton, Joseph E.,** Douglas Aircraft Co., Inc.
T **Stark, Robert R.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
T **Stargos, Basil,** War Dept.
T **Stary, Louis J.,** Northrop Aircraft, Inc.
AF **Stearns, Ray,** General Electric Co.
T **Stebley, Robert.**
F **Stedman, Air Vice-Marshall E. W.,** Dept. of National Defence for Air, Canada.
AF **Stefansson, Vihjalmur,** Pan American Airways System.
T **Steinbacher, F. R.,** Univ. of Michigan.
T **Steiner, John E.,** Boeing Aircraft Co.
I **Stengel, J. Frank,** Telephonics Corp.
T **Stephens, Boyd C.,** Pan American Airways System.
M **Stephens, Roma L.,** Goodyear Aircraft Corp.
T **Stern, Robert G.,** Airplane Div., Curtiss-Wright Corp.
M **Stetson, George L.,** Shell Oil Co.
T **Stetson, Richard H.,** Sperry Gyroscope Co., Inc.
T **Stevens, Blaine K.,** Dow Chemical Co.
T **Stevens, Emerson W.,** Airplane Div., Curtiss-Wright Corp.
T **Stevens, Geo. P.,** Vega Aircraft Corp.
M **Stevens, H. L.,** Royal Aircraft Establishment, England.
T **Stevens, Melvin E.,** Vultee Aircraft, Inc.
T **Stevens, William P., Jr.,** Lockheed Aircraft Corp.

M **Stevenson, A. R., Jr.,** General Electric Co.
M **Stewart, Charles D.,** Lockheed Aircraft Corp.
AF **Stewart, C. J.,** Air Ministry, England.
AF **Stewart, Earle,** The Glenn L. Martin Co.
M **Stewart, Wm. Fred,** Spartan Aircraft Co.
T **Stewart, Dr. H. J.,** Calif. Inst. of Tech.
T **Steyer, Wesley A.,** Goodyear Aircraft Corp.
M **Stiles, John R.,** Goodyear Aircraft Corp.
T **Stillwell, Prof. H. S.,** Univ. of Kansas.
T **Stinson, Katherine,** C.A.A.
T **Stivers, L. S., Jr.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Stocking, L. E.**
T **Stoessel, R. F.,** Lockheed Aircraft Corp.
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T **Stoner, Eliot F.,** Pacific Railway Equipment Co.
T **Storey, Lon, Jr.,** Lockheed Aircraft Corp.
AF **Stoughton, Milton F.,** Vultee Aircraft, Inc.
M **Stout, E. G.,** Consolidated Aircraft Corp.
T **Stout, Joseph W., Jr.,** Pennsylvania-Central Airlines.
F **Stout, William B.,** Stout Eng. Laboratories.
T **Stout, William M.,** Airplane Div., Curtiss-Wright Corp.
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T **Strandberg, Joel E.,** Lockheed Aircraft Corp.
AF **Strang, Charles R.,** Douglas Aircraft Co., Inc.
T **Strauss, Irvin R.,** Boeing Aircraft Co.
T **Strausser, Charles B.,** Goodyear Aircraft Corp.
T **Streed, R. W.,** Consolidated Aircraft Corp.
T **Street, Robert E.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Strickland, John T.,** War Dept.
M **Stieglitz, William I.,** Fleetwings, Inc.
T **Strom, Gordon H.,** New York Univ.
T **Strong, Ens. E. W.,** Navy Dept.
M **Strunk, K. G.,** Breeze Corporations, Inc.
T **Struthers, John H.,** Consolidated Aircraft Corp.
AF **Stryker, Carleton E.,** W.P.B.
T **Stuart, Joseph, III,** Aeroproducts Div., General Motors Corp.
T **Stubbs, George R.,** C.A.A.
M **Stulen, Foster B.,** Pittsburgh Screw & Bolt Corp.
T **Stull, Donald L.,** Airplane Div., Curtiss-Wright Corp.
T **Sturm, F. W.,** Andover Kent Aviation Corp.
M **Sullivan, Eugene D.,** Air Supply Co.
M **Sullivan, George C.,** Lockheed Aircraft Corp.
T **Summers, James L.,** Ames Aero. Lab., N.A.C.A.
M **Sumner, Paul A.,** Brewster Aeronautical Corp.
I **Sundem, Lt. Trond Alex.,** U.S. Army Air Forces.
T **Surbeck, Major Richard U.,** U.S. Army Air Forces.
T **Sussman, Herman R.,** War Dept.
F **Sutton, Harry A.,** Consolidated Aircraft Corp.
T **Sutton, John R.,** Airplane Div., Curtiss-Wright Corp.
T **Sutton, Robert J.,** Douglas Aircraft Co., Inc.
AF **Sutton, Wilson L.,** Grumman Aircraft Eng. Corp.
I **Swailes, Earl J.,** Navy Dept.
T **Swan, Gail H. S.,** Fleetwings, Inc.
T **Swancutt, Robert F.,** Douglas Aircraft Co., Inc.
T **Swanson, Douglas,** Consolidated Aircraft Corp.
T **Swanson, LeRoy D.,** The Glenn L. Martin Co.
T **Swanson, Robert S.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Swanson, Stanley H.,** Boeing School of Aeronautics.
T **Sweberg, Harold H.,** Langley Mem. Aero. Lab., N.A.C.A.
I **Sweeney, Beauregard,** Cox & Stevens Aircraft Corp.
T **Sweet, Capt. Floyd J.,** U.S. Army Air Forces.
T **Sweet, Harold R.,** North American Aviation, Inc.
M **Sweetser, Converse W.,** Grumman Aircraft Eng. Corp.
M **Swisher, Leon N.,** Sperry Gyroscope Co., Inc.
T **Syddall, W. H.,** Rotol Airscrews, Ltd., England.
M **Sylvander, R. C.,** Pioneer Instrument Div., Bendix Aviation Corp.
AF **Symington, W. W., Jr.,** The Glenn L. Martin Co.
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T **Tangren, R. Fulton,** Airplane Div., Curtiss-Wright Corp.
I **Tatnall, Francis G.,** Baldwin-Southwark Div., Baldwin Locomotive Works.
T **Taubman, Samuel,** Lockheed Aircraft Corp.
M **Tauson, Peter O.,** Bell Aircraft Corp.
F **Taylor, Prof. C. Fayette,** Mass. Inst. of Tech.
M **Taylor, C. G.,** Aeronautical Consultant.
F **Taylor, Prof. Edward S.,** Mass. Inst. of Tech.
AF **Taylor, George F.,** War Dept.
HF **Taylor, Prof. G. I.,** Cambridge Univ., England.
T **Taylor, M. Francis,** The Glenn L. Martin Co.
F **Taylor, Philip B.,** Wright Aeronautical Corp. Div., Curtiss-Wright Corp.
M **Tchemessoff, Serge,** Ford Motor Co.
T **Teague, B. M., Jr.,** The Glenn L. Martin Co.
T **Tegtmeyer, Ray C.,** Airplane Div., Curtiss-Wright Corp.
AF **Teichmann, Prof. Frederick K.,** New York Univ.
T **Telesco, Lt. Lee A.,** U.S. Army Air Forces.
T **Tenedini, A. S.,** Casey Jones School of Aeronautics.
I **Ternes, R. F.,** U.S. Rubber Co.
AF **Thaden, H. V.,** Thaden Eng. Corp.
M **Tharratt, George,** Adel Precision Products Corp.
T **Thayer, Harold B.,** United Air Lines Transport Corp.
T **Theiss, Edward C.,** War Dept.
T **Theobald, Phillip E.,** Aeroproducts Div., General Motors Corp.
F **Theodorsen, Dr. Theodore,** Langley Mem. Aero. Lab., N.A.C.A.
T **Theriault, Paul W.,** Lockheed Aircraft Corp.
M **Thibodeau, Robert E.,** Continental Motors Corp.
AF **Thieblot, A. J.,** Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.
T **Thigpen, B. M.,** Navy Dept.
M **Thomas, Charles F.,** Lockheed Aircraft Corp.
AF **Thomas, Frederick M.,** W.P.B.
M **Thomas, Harold W.,** Airplane Div., Curtiss-Wright Corp.
T **Thomas, Kenneth F.,** SKF Industries, Inc.
T **Thomas, Walter C.,** Navy Dept.
T **Thomas, William S.,** C.A.A.
T **Thomas, William W.,** Airplane Div., Curtiss-Wright Corp.
T **Thompson, Lt. Donald M.,** U.S. Army Air Forces.
T **Thompson, Douglas G.,** War Dept.
AF **Thompson, F. L.,** Langley Mem. Aero. Lab., N.A.C.A.
M **Thompson, Frederick B.,** Thompson Aviation Publishers.
AF **Thompson, Prof. M. J.,** Univ. of Texas.
T **Thompson, Oscar N.,** Consolidated Aircraft Corp.
M **Thompson, Robert A.,** Univ. of Florida.
T **Thompson, Richard H.,** Douglas Aircraft Co., Inc.
M **Thoren, Rudolph L.,** Lockheed Aircraft Corp.
T **Thorjusen, Philip S.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
AF **Thornbury, Paul C.,** North American Aviation, Inc.
T **Thornley, Ray S.,** The Glenn L. Martin Co.
HM **Thornton, Air Commodore H. N.,** British Embassy.
AF **Thorp, George B.,** Carnegie Museum of Pittsburgh.
T **Thrall, Edward W., Jr.,** Douglas Aircraft Co., Inc.
T **Thurlow, David W.,** Boeing Aircraft Co.
AF **Thurston, A. P.,** England.
M **Thurston, Arthur L.,** Cox & Stevens Aircraft Corp.
T **Thurston, David B.,** Grumman Aircraft Eng. Corp.
I **Tichenor, Frank A.,** *Aero Digest; Sportsman Pilot; Revista Aerea* magazines.

T **Tiedeman, Robert K.,** Propeller Div., Curtiss-Wright Corp.
M **Tifford, Arthur N.,** Airplane Div., Curtiss-Wright Corp.
AF **Tilgner, Charles, Jr.,** Grumman Aircraft Eng. Corp.
AF **Tillinghast, T. E.,** United Aircraft Service Corp.
T **Tills, Ens. Robert G.,** U.S. Navy.
T **Tilney, Ralph B.,** Pan American Airways-Africa Ltd.
AF **Tiltman, A. Hessell,** Airspeed (1934) Ltd.; Fireproof Tanks, Ltd., England.
F **Timoshenko, Prof. S.,** Stanford Univ.
T **Tingley, Sanford,** Goodyear Aircraft Corp.
T **Titzler, Lt. Henry N.,** U.S. Army Air Forces.
F **Tizard, Sir Henry Thomas,** Imperial College of Science & Technology, England.
M **Tjaarda, John,** Briggs Mfg. Co.
T **Tobin, F. Wallace, Jr.,** Navy Dept.
T **Toll, Thomas A.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Tomren, Raymond H.,** Airplane Div., Curtiss-Wright Corp.
T **Toumanoff, George I.,** Lockheed Aircraft Corp.
M **Towers, Vice-Admiral John H.,** U.S. Navy.
T **Towle, Charles J.,** Grumman Aircraft Eng. Corp.
F **Townend, Dr. H. C. H.,** Admiralty, England.
M **Townsend, Francis D.,** Bell Aircraft Corp.
T **Townsend, Samuel J. C.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
T **Townsend, Vernon G.,** The Glenn L. Martin-Nebraska Co.
T **Tracy, Thomas N.,** Aeronautical Consultant.
T **Treide, Paul H.,** The Glenn L. Martin Co.
M **Trent, William C.,** Navy Dept.
T **Trigg, Leslie J.,** Hamilton Standard Propellers Div., United Aircraft Corp.
T **Trimarchi, Vincent C.,** Navy Dept.
M **Trimble, George S., Jr.,** The Glenn L. Martin Co.
T **Tripp, Robert,** Lockheed Aircraft Corp.
I **Trippe, J. T.,** Pan American Airways System.
AF **Troller, Theodor H.,** Guggenheim Airship Inst.
T **Trout, Ray G.,** Taylorcraft Aircraft Co.
T **Troy, Leonard,** Brewster Aeronautical Corp.
T **Trueblood, Joseph R.,** The Glenn L. Martin Co.
T **Tsao, Capt. C. C.,** Central Aircraft Co., China.
T **Tsien, H. C.,** Chinese Aircraft Engine Factory.
T **Tsien, Hsue-shen,** Calif. Inst. of Tech.
M **Tsongas, Alexander,** Vultee Aircraft, Inc.
T **Tsu, Jack C. N.,** Kroehler Mfg. Co.
T **Tucker, Lt. John M.,** U.S. Army Air Forces.
T **Tucker, Warren A.,** Langley Mem. Aero. Lab., N.A.C.A.
F **Tuckerman, Dr. L. B.,** National Bureau of Standards.
T **Tufts, Orren B.,** Lockheed Aircraft Corp.
T **Tulpan, Theodore F.,** The Glenn L. Martin Co.
AF **Tupper, K. F.,** National Research Council, Canada.
T **Turner, A. S.,** Douglas Aircraft Co., Inc.
M **Turner, Harry M.,** The Glenn L. Martin Co.
T **Turner, K. B.,** Bristol Aircraft Div., Universal Moulded Products Corp.
T **Turner, L. I., Jr.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Turner, M. J.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Tuttle, Col. A. D.,** United Air Lines Transport Corp.
T **Tuttle, Orvil S.,** U.S. Plywood Corp.
M **Tuttle, Ralph M.,** Allied Aviation Corp.
T **Tuttle, Roy M., Jr.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.
M **Tweney, Prof. George H.,** Univ. of Detroit.
T **Tyler, Clarence M., Jr.,** Airplane Div., Curtiss-Wright Corp.

T **Uddenberg, Robert C.,** Boeing Aircraft Co.
T **Uhrich, Harold R.,** Sensenich Bros.
M **Uihlein, Dr. Alfred,** Mayo Foundation.
T **Ullett, James H.,** U.S. Army Air Forces.
I **Ulmann, A. E.,** Dowty Equipment Corp.
M **Umschweif, Alfred I.,** Brewster Aeronautical Corp.
T **Updegrove, Henry T., Jr.,** College of the City of New York.
F **Upson, Ralph H.,** H. J. Heinz Co.
M **Upton, Virgil S.,** Vega Aircraft Corp.
T **Urbach, S. D.,** G & A Aircraft, Inc.
T **Urquhart, Robert G.,** Vought-Sikorsky Aircraft Div., United Aircraft Corp.

M **Valentine, E. Floyd,** Langley Mem. Aero. Lab., N.A.C.A.
M **Valk, Wm. E., Jr.,** Curtiss-Wright Corp.
M **Van Alstyne, H. L.,** Hamilton Standard Propellers Div., United Aircraft Corp.
T **Van Damme, Joseph,** National Research Council, Canada.
M **Vanderlipp, N. F.,** Fairchild Aircraft Ltd., Canada.
M **Vandermeer, Will,** Ryan Aeronautical Co.
I **Van Dusen, C. A.,** Brewster Aeronautical Corp.
T **Van Every, Kermit E.,** Douglas Aircraft Co., Inc.
AF **Van Zandt, J. Parker,** Dept. of Commerce.
T **Varhanik, Harold J.,** Lockheed Aircraft Corp.
T **Varrieur, Albert L.,** The Glenn L. Martin Co.
I **Vaughan, Guy W.,** Curtiss-Wright Corp.
T **Veck, Milton F.,** Airplane Div., Curtiss-Wright Corp.
T **Veeder, Ronald A.,** Transcontinental & Western Air, Inc.
T **Velazquez, J. L.,** Douglas Aircraft Co., Inc.
T **Vendrell, J. A.,** Lloyd Aereo Boliviana, Bolivia.
M **Vensel, J. R.,** Langley Mem. Aero. Lab., N.A.C.A.
T **Ventura, J. J.,** McDonnell Aircraft Co.
F **Verdon-Roe, Sir Alliott,** Saunders-Roe Ltd., England.
AF **Verville, A. V.,** Consulting Engineer.
T **Victoreen, Vincent E.,** Lockheed Aircraft Corp.
M **Victory, John F.,** N.A.C.A.
M **Vidal, Eugene L.,** Vidal Research Corp.; V. Aircraft Co.
M **Villiers, Amherst,** The Straight Corp., England.
AF **Vincent, J. G.,** Packard Motor Car Co.
T **Vincenti, Walter G.,** Ames Aero. Lab., N.A.C.A.
M **Viteles, Dr. Morris S.,** Univ. of Pennsylvania; National Research Council.
T **Vicek, Frank J.,** Lockheed Aircraft Corp.
T **Vogel, Lt. John F.,** U.S. Army Air Forces.
T **Vogel, William F.,** The Glenn L. Martin Co.
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M **Von Eschen, Garvin L.,** Univ. of Minnesota.
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HF **von Kármán, Dr. Th.,** Calif. Inst. of Tech.
F **von Mises, Prof. Richard E.,** Harvard Univ.
T **Voorhees, Alston B., Jr.,** Boeing Aircraft Co.
T **Voyles, Lt. James H., Jr.,** U.S. Army Air Forces.
M **Vye, Stanley A.,** Douglas Aircraft Co., Inc.

T **Wagenknecht, Kurt,** W.P.B.
T **Wahle, Jack A.,** Pan American Air Ferries, Inc.
AF **Wait, Group Capt. Geo. E.,** R.C.A.F., Canada.
AF **Wait, William, Jr.,** Brewster Aeronautical Corp.
T **Wald, Quentin,** United Aircraft Corp.
F **Walker, C. C.,** de Havilland Aircraft Co. Ltd., England.
M **Walker, Ernest E.,** Aviation Writer.
T **Walker, Lt. John J.,** U.S. Army.
I **Walker, Randolph C.,** Aircraft Accessories Corp.
T **Walkover, Louis,** Airplane Div., Curtiss-Wright Corp.
T **Walkowicz, Lt. T. F.,** U.S. Army Air Forces.
T **Wall, Thomas F.,** Douglas Aircraft Co., Inc.
T **Wallace, Francis L.,** American Export Airlines, Inc.
T **Wallace, H. H., Jr.,** Chandler-Evans Corp.
T **Wallace, John J.,** Bristol Aircraft Div., Universal Moulded Products Corp.

T **Wallace, Robert D.,** Lockheed Aircraft Corp.
M **Waller, Jason J.,** Fairchild Aircraft Ltd., Canada.
T **Waller, Lt. John C.,** U.S. Army.
T **Walling, Walter C.,** Lockheed Aircraft Corp.
T **Walseth, Lt. M. E.,** U.S. Army Air Forces.
I **Walsh, Raycroft,** United Aircraft Corp.
T **Walter, Don L.,** Douglas Aircraft Co., Inc.
T **Walters, Earl R.,** Consolidated Aircraft Corp.
T **Walters, Lawrence, Jr.,** Harlow Aircraft Co.
T **Walton, Arthur L.,** Douglas Aircraft Co., Inc.
M **Walton, Edwin C.,** W.P.B.
T **Walton, O. Alarik,** Grumman Aircraft Eng. Corp.
T **Wang, C. H.**
M **Ward, J. Carlton, Jr.,** Fairchild Engine & Airplane Corp.
M **Ward, Kenneth E.,** Consolidated Aircraft Corp.
AF **Ward, N. F.,** Beech Aircraft Corp.
T **Ward, Vincent S.,** Adirondack Steel Co.
T **Wardle, Meredith C.,** Airplane Div., Curtiss-Wright Corp.
T **Ware, Joseph F., Jr.,** Lockheed Aircraft Corp.
AF **Ware, Raymond,** Consulting Engineer.
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T **Warner, A. A.,** Douglas Aircraft Co., Inc.
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T **Warner, Donald D.,** The Glenn L. Martin Co.
F **Warner, Edward P.,** N.A.C.A.; C.A.B.
M **Warner, Gerald E.,** Standard Oil Co. of Venezuela.
M **Warner, John A. C.,** Society of Automotive Engineers.
I **Warner, Percy deF., II,** C.A.A.
AF **Warner, William O.,** Warner Aircraft Corp.
T **Warren, Major Roy E.,** U.S. Army Air Forces.
T **Warrener, Arthur E.,** Clark Ruse Aircraft Ltd., Canada.
I **Warrington, C. H.,** Vulcan Iron Works, Inc.
T **Warshaw, Seymour,** Navy Dept.
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